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VOLUME 9, No. 2 FEBRUARY 1957

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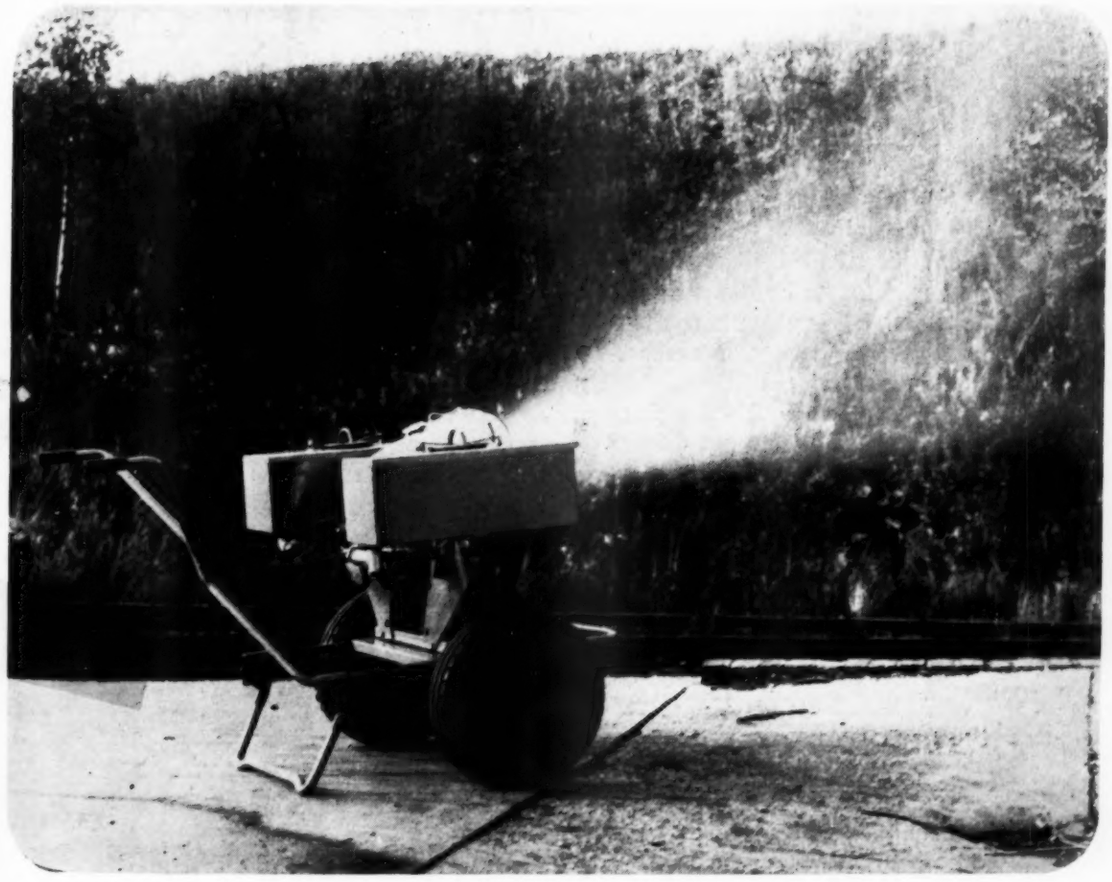

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WORLD CROPS

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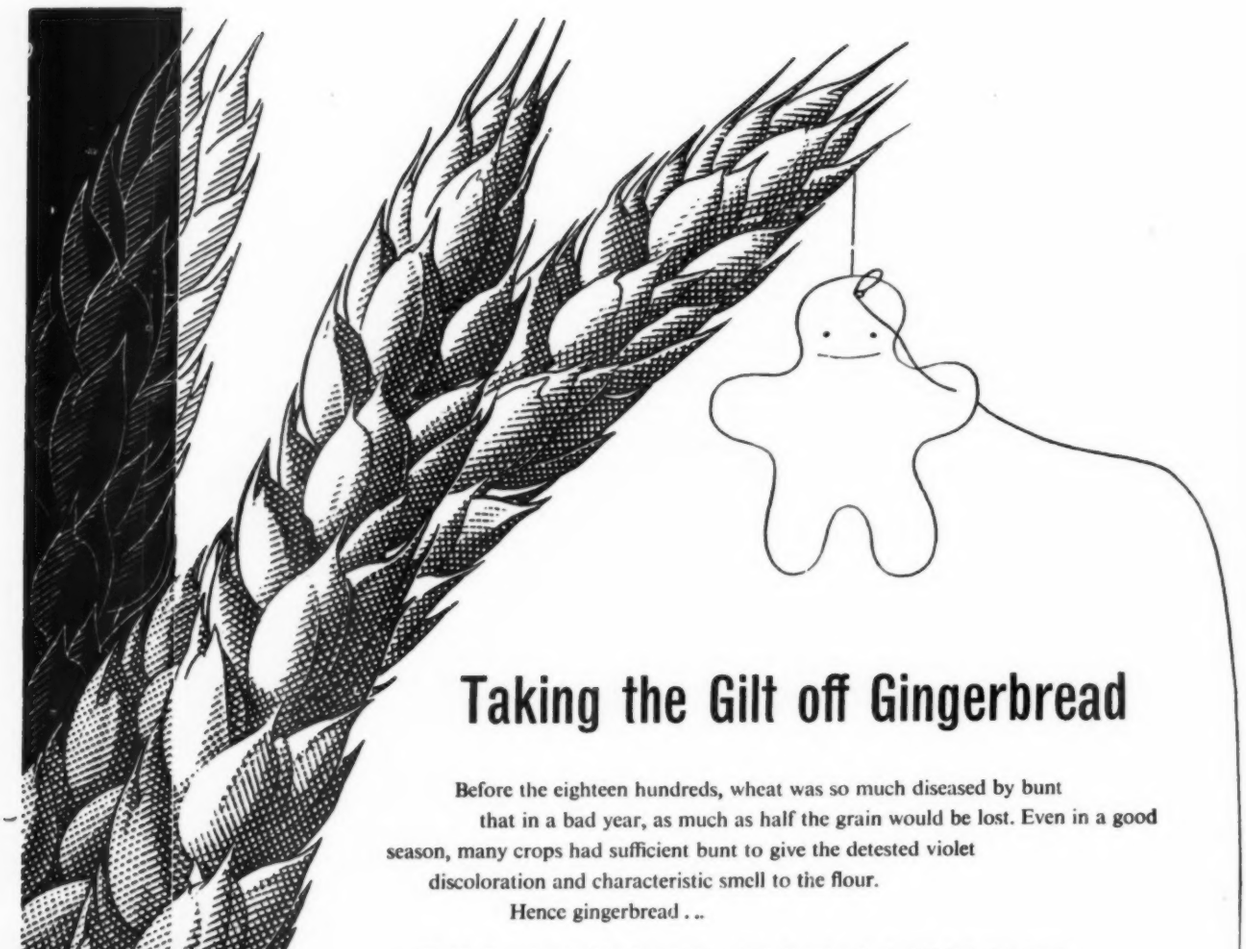

Taking the Gilt off Gingerbread

Before the eighteen hundreds, wheat was so much diseased by bunt that in a bad year, as much as half the grain would be lost. Even in a good season, many crops had sufficient bunt to give the detested violet discoloration and characteristic smell to the flour.
Hence gingerbread . . .

Highly flavoured with ginger, these treacle cakes in fanciful shapes were gilded to make them still more attractive. But take the gilt and the ginger from the gingerbread and we find it was just a cunning way of disposing of rather unpalatable flour! No one could detect the smell and colour of bunt under such a heavy disguise. Then work was begun to prevent the disease.

Treating cereal seed with organo-mercurial seed dressing against bunt is now standard practice. And the pioneer work by Plant Protection Ltd on a combined organo-mercurial/gamma BHC dressing for protection against both bunt *and* wireworm has become another standard farming practice.

There is unending research by Plant Protection Ltd and its parent company Imperial Chemical Industries Ltd, working in collaboration with universities, government research organisations and other official bodies throughout the world. Their aim is to find new chemical treatments to protect crops from weeds, pests and diseases. The benefits of this research are made available through their Agents to farmers and growers at home and overseas.

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Editorial Comment

Survival—revival

THE story of pyrethrum in the past decade is one of dramatic swings. This natural insecticide, grown as a crop in warm and high altitudes, seemed tremendously threatened immediately after the war by the advent of DDT and the later chlorinated hydrocarbon synthetic insecticides. As some of the limitations of these new substances emerged, pyrethrum's prospects looked brighter again. Then came the synthesis of allethrin—so closely related to the pyrethrins which make pyrethrum flower extracts toxic to insects. The synthetic threat seemed graver still—but again there were limitations, and allethrin seems now to have developed more as a diluent of natural pyrethrins than as an insecticide in its own right. Thus a market that suffered near-collapse in 1947 has gradually recovered and by 1954 demand for pyrethrum flowers was again greater than production.

Although pyrethrum cropping did not begin in Kenya until 1926—with actual exporting starting in 1932—production today has risen to nearly 8 million lb. per annum. In Tanganyika about a quarter of this amount is grown. There is also a substantial pyrethrum industry in the Belgian Congo, producing about 4,500,000 lb. a year; there it is even more vital in local economy, for the high altitude soils are volcanic by origin, suitable for good pyrethrum-flower growth, but not for other crops. Totally, therefore, African pyrethrum farming has shattered the one-time Japanese monopoly. No world crop seems to be such a certain dollar-earner—at least two-thirds of African production is annually exported to the U.S.A. and even this does not satisfy the demand. With threats from synthetic competitors dispersed, a doubling of exports to America is anticipated in only a few years' time.

This expansion will be accompanied with a revolutionary change in the method of ' marketing '. Hitherto most of the trade has been in the form of baled flowers, the pyrethrum extract being made in American factories. But it takes 100 lb. of flowers to make about 1½ lb. of the extract. Very great transport economies are possible, therefore, if extraction is carried out before exporting. There has been a privately owned extraction plant in Kenya for several years; and one is nearing completion at present in the Congo. In addition, there are plans in both areas for additional extraction plants, and within a few years it is probable that the total African crop will be converted into extract before shipment. Kenya's extraction capacity alone will be greater than the present pyrethrum flower output of Africa if plans of the Kenya Pyrethrum Board are implemented, but this surplus capacity allows, of course, for the expected increases in annual harvesting.

In an age when specialised natural products have been fighting difficult or forlorn battles with new synthetic relatives, the survival and subsequent revival of natural pyrethrum is reasonably described as exceptional. Today a crop that some thought to be doomed only a few years ago is confidently expanding its acreage.

Soil moisture determinations

SOIL physics is another field of research that is benefiting from the application of atomic energy. Although much work has been done in studying the physical properties of soils, the techniques used in the past have not been wholly satisfactory. The important properties which affect plant growth are moisture, aeration, temperature and mechanical condition. Methods are now being developed in the U.S.A., reported in *Crops and Soils*, to measure these with radioisotopes.

Scientists consider that they have developed a method for measuring soil moisture by neutron reflection that comes close to being ideal. This provides fairly constant readings and does not disturb the soil profile after the measuring tube is first inserted. The disadvantages that have shown themselves so far are that the measurement zone is not well defined; the method is not sensitive to the energy which holds moisture in the soil; and it is expensive, slow and requires heavy equipment. It is expected, however, that further research and improvements will overcome the present shortcomings.

The agricultural revolution

WHEN economists like Malthus gloomily predicted that man, because of population increases, faced inevitable starvation, they reckoned without the progress of scientific technology which, greatly accelerated during the past 20 years, has become a basic force in revolutionising agriculture.

The world's surface suitable for agriculture amounts to 2,500 million acres. This corresponds almost exactly to one acre per human being. However, the distribution of the arable land is quite uneven. For example, a Japanese has only one-fourth of an acre from which to feed himself. An American, on the other hand, has the output of 7.9 acres of land to fill his needs.

There is a likelihood, however, that this 7.9 acres per person will shrink decidedly within the next half-century. The upsurge in birth rate, which began suddenly about the 1930s, has outdated all forecasts

and it is now predicted that the population of the U.S.A. will reach 200 million within 25 years. If birth rates continue their present trend within the life span of another generation, the U.S. population might reach 300 million and the land available for meeting the food needs of each person will drop to a figure more nearly comparable to the present state of affairs in some of the crowded countries of Europe, such as Holland, Denmark and England.

Back in 1920 one American farm worker produced enough food and fibre for himself and seven others. By 1940 he could produce for himself and 10 others. Today he produces enough for 18 others, while in Soviet Russia his counterpart produces only enough for three others. In many other countries industry is insignificant or non-existent, because 80 to 90% of the people must devote their efforts to producing enough to eat—and often are unable to avoid starvation.

The real hope for future food production is the advance of technology. Since 1920 the increased demands of America's growing population have been met in part through improved farming practices and in part through the elimination of the horse, once an important consumer of grains.

Chemical control is continually reducing losses due to diseases, insects and parasites. We can expect faster-growing and more nutritious crop plants and animals as a result of combined research in chemistry and biology. Finally, we expect to advance the farmer's knowledge of the soil itself. Work with chemical soil conditioners and the study of soil organisms leads scientists to believe that chemicals may be able to supplement soil contributions to crop production in measures that will far outstrip the job now performed by nature.

Hungary, Suez . . .

EVEN if more or less normal economic activity is resumed as quickly as possible, recent events in Eastern Europe and the Middle East are bound to have important effects on the economies of European countries, the United Nations Economic Commission for Europe (ECE) Secretariat notes in a report prepared for its Quarterly Economic Bulletin for Europe.

The Secretariat does not yet feel able to estimate the full effects of the Hungarian uprising, but suggests that, in addition to the losses in human lives, a most severe and dangerous drop in standards of living, with serious consequences for health, is the immediate result and seems bound to persist unless adequate relief measures are taken.

It is no easier, says the Secretariat, to assess the full effects on the economies of the Western European countries of the blocking of the Suez Canal and the damage to oil pipelines or of the general heightening of political tensions as a result of the recent disturbances to peace in the Middle East. A shortage of tanker capacity seems likely to be the main factor limiting Western Europe's oil supplies and if the Canal remains blocked for long the longer hauls from the Persian Gulf round the Cape or across the Atlantic seem certain to reduce Western Europe's total oil supplies as well as to raise their delivered cost. If an overall shortage should persist for any considerable length of time, measures to allocate supplies as between countries, and within countries as between industries, will, the ECE Secretariat suggests, become necessary.

The ECE report considers the possibility of minimising the effects of oil shortage by stepping up imports of coal from the U.S.A., now running at a rate of about 50 million tons a year. It mentions the uncertainty whether or not loading facilities in U.S. ports would become an obstacle to a very substantial rise in the rate of shipment of coal to Europe, but considers that some increase would be possible.

Nevertheless, the ECE Secretariat considers that the possibility cannot be excluded that a decrease in the supply of fuel oil will entail a certain reduction of industrial output in Western Europe. But they suggest that it should be possible, within limits, to concentrate reductions in fuel supplies in each country on those industries where there is least danger that a fall in production will start a chain reaction spreading throughout the economy.

. . . and Russia

REPORTING on harvest results in the U.S.S.R. and Eastern Europe, the ECE Secretariat say that an excellent grain harvest is indicated in the Soviet Union and Czechoslovakia and about average results in Poland and Eastern Germany. In Hungary, however, the harvest was distinctly below average, as it was in Bulgaria. The good results in the Soviet Union reflect the successful harvests in the virgin lands in Kazakhstan and Siberia, and total State grain procurements this year will be well over double the amount regarded as normal before the virgin lands campaign.

The Secretariat also report a startling rise in milk production in the Soviet Union, where deliveries by collective farms rose by 38% during the 11 months from 1 October, 1955, to 31 August, 1956. They quote figures for the Ukraine which show that after a period of several years yields had climbed only slowly from an extremely low level, while the number of cows increased at a remarkable rate. This change over to a rapid increase in yields is to be explained by the fact that the inordinate increase in the number of milk cows has now been stopped. The recent increase in Soviet milk yields, it is suggested, seems to reflect the belated beginning of an adjustment of cow numbers to fodder availabilities so as to avoid under-feeding.

The Secretariat suggest that some Eastern European countries are in a similar position, having herds of cows which are too big in the sense that an increase of

herds without a more than proportionate increase in fodder supplies is not to be recommended. The report quotes figures of pre- and post-war milk yields in both Eastern and Western European countries which show a rise in yields in the Western countries and falls in several Eastern European countries.

Hybrid vigour

IN some cultivated plants (but not all) in-breeding will have an adverse effect on vigour; and, conversely, crossing between different lines of plants will often give us remarkably vigorous offspring. Not merely from a purely scientific standpoint, but also from a practical one, this subject is of the greatest interest.

We do not here propose to go further into the theories and hypotheses which explain the results, but to apply them to the human race, and in particular to Britain—the target of successive invasions by the Romans, the Normans and the warring tribes of Northern Europe and the refuge of the homeless and persecuted through the ages. Is not hybrid vigour, expressed in different forms, and the ability to find the right kind of man at the right time in periods of national emergency, the secret of Britain's greatness and her ability to worry through almost hopeless situations?

Now comes the news that 100,000 refugees from tortured Hungary will be bringing their culture and skills to those countries who have generously offered them refuge. The Hungarians are mainly an agricultural people and the countries who help them stand to gain, not only through their skills, but also through the introduction of new blood.

Throughout the world there exists a vast field of endeavour which calls for men as well as money. The opportunity is there for the men of courage and enterprise from Hungary.

Protection of stored grain

THE U.S. Department of Agriculture estimates that in America alone insects and rodents destroy between £60 million and £70 million worth of grain annually. It was against this background that Dr. W. E. Dove, of the Food Machinery and Chemical Corporation, Baltimore, Maryland, U.S.A., gave his paper, 'The Protection of Stored Grains with Pyrethrins and Piperonyl Butoxide', to the International Congress of Entomologists, held in Montreal in August 1956. This outlines an effective, economical and non-poisonous means for the prevention and control of insect pests attacking grain in store.

Piperonyl butoxide is only slightly toxic to insects when used alone, but when combined with pyrethrins —extracted from African pyrethrum flowers—it can increase the biological efficiency by as much as 15 times the potency of the pyrethrins alone.

A representative formula for a grain-protectant powder consists of pyrethrins 0.06% and piperonyl butoxide 1%. In its manufacture a concentrated dust base is mixed at the rate of 25% with 75% of fibrous talc. This mixture is applied at the rate of 80–100 lb. per 1,000 bushels of grain.

A liquid grain-protectant spray should contain pyrethrins 6%, piperonyl butoxide 60% and an emulsifying agent. After dilution with 29 volumes of water this gives a spray containing 0.2% pyrethrins and 2% piperonyl butoxide and this is applied at the rate of 5 gal. per 1,000 bushels of grain.

Insecticides, based on pyrethrum, may also be put to other uses; for instance, for the control of fruit flies in canneries and for dipping cracked tomatoes or injured fruits after harvesting.

The combination of efficiency and safety associated with these compounds has led to the U.S. Government giving its approval to the use of this pesticide on grain after harvest. It can equally be applied to peanuts, copra, cocoa beans, flaxseed, cottonseed and a variety of fruits.

Sucrochemistry

ADDRESSING the Hawaiian Sugar Planters Association in Honolulu recently, Mr. H. B. Hass, President of the Sugar Research Foundation Inc., of New York, described how this body was fast becoming the 'use-research' agency for the sugar industry. The original members of the Foundation were U.S.A., Canada, Cuba and Dominica. Subsequently the Philippines came in, followed by Great Britain, Sweden, Denmark, Peru and India.

He gave an account of recently developed new uses for sugar and its waste products. First he described the new sugar ester detergents, which are made from the methyl esters of fatty acids and sucrose by an alcoholysis reaction—a chemical marriage of fat and sugar. He said that they are excellent detergents and emulsifying agents, completely indifferent to hardness in water and they function as lime soap dispersants. Market analysts have estimated that, in 10 years, the annual world sale of detergents may reach 2½ million tons.

The same kind of chemistry, he continued, will also yield superior drying oils for paints. These are the methyl esters of highly unsaturated fatty acids combined with a sucrose molecule with attached acyl groups. The resulting oils dry faster to give harder, films compared to the natural drying oils, from which they were derived.

They have also discovered a strong, pale-coloured, low cost thermo-setting plastic, which is one-third sugar and less expensive than many of the materials now used to make plastics. The possibilities are enormous, as it is estimated that in 1975 eight million

tons of plastics will be used annually in the U.S.A. alone.

A new family of pesticides has also been developed by combining sugar chemically with industrial poisons. The sugar modifies their properties without affecting their toxicity. Thus the trichloracetates of sugar are weedkillers like sodium trichloracetate, but the sugar derivates are only slightly soluble in water. They dissolve in oils, so they may be applied without the corresponding problem of the sodium salt. They should have less tendency to be washed off plants during rain.

The past three years, he continued, have seen a 30-million-pound per year furfural plant and a bagasse plant go into operation. Furfural is mostly used for nylon and today there are stockings which started from bagasse.

The main problem of the sugar industry is still to help to feed the world, as the sugar-cane will provide more food energy per acre-year than any other plant grown commercially. However, it is only in countries where protein foods are plentiful that the consumption of sugar *per capita* is high. Where there is little meat, milk, fish, cheese or legumes, then cereals, which provide some proteins, must always be preferred to sugar, which furnishes none. If the rice-eating peoples could sugar their rice more heavily, they could have more food energy *per capita*, but they will not have a balanced diet unless they can simultaneously put some milk on the rice or in some other way obtain the protein which they need.

There are, he said, several approaches to this problem. Yeast can be produced on molasses and ammonia, and this yeast can make protein, or else molasses or sugar-beet pulp can be ammoniated and fed to cattle to obtain meat or milk.

The results with ammoniated beet pulp have been most encouraging and feeding tests have been carried out at the Amalgamated Sugar Co., all with favourable results. The product is free from toxicity and the gains in weight of cattle fed on this material surpassed those of cattle fed on cottonseed meal. Work on dairy cattle has begun at Shinfield, England, and on sheep at Utah Agricultural College. Cattle, sheep, turkeys, pigs and other farm animals all like sugar and can utilise it efficiently.

Finally, he concluded, we have learned much about the effect of sugar on the human body. Prof. D. A. Turner, of the U.S.A., has shown that people who could not otherwise digest fat efficiently can do so with a little sugar ester added to their diet. This is beginning to look like a major advance in geriatrics (the study of disorders associated with old age), for failure to assimilate fat efficiently is the commonest digestive disturbance in the U.S.A. Nutritionists are gradually realising that arterio-sclerosis is the number one killer —if people eat less carbohydrate foods, they invariably eat more fat, and it is now recognised that there is a close relationship between high-fat diets and heart trouble.

Electricity is life

THE Electrical Research Association organised a two-day conference in London recently to receive suggestions for future research on the applications of electricity to increase world supplies of food necessitated by the big increases in population.

It is indeed a welcome and a healthy sign of the times that the farmer is now being increasingly consulted on his problems and needs and that the significance and implications of the recent rapid advances in science, as applied to agriculture, are being carefully introduced and properly explained to him by the research scientist and the technician.

Sir Harold Hartley, F.R.S., who presided, said that the purpose of the conference was to discover what lines of research could be most profitably developed in the interests of agriculture. ' It will be a combined operation ', he said, ' to get the biologist, the physiologist, the chemist, the electrical and the plant engineer to work together as a team to meet the needs of the farmer. The gaps must be bridged and the various interests must keep in far closer contact than in the past '.

' There is a great need ', according to Prof. A. N. Duckham, ' for biophysical research to determine the responses of plants, animals and insects to electromagnetic and similar treatments '. The same treatment might also be applied for pest and fungus control. Instruments to measure crops for quantity, quality, moisture content and rate of growth, and also to determine the workability of a soil, were envisaged. An interesting suggestion he made was the use of the two-way radio-telephone between the farmer and his workers as an aid to management.

Dr. J. Hudson, speaking on the subject of ' The Economics of Environmental Control ' said that the most urgent need was for the development of growth rooms and experimental glasshouses with a high degree of control. Research would then show how electricity can best be applied to the economics of crop production.

According to Mr. J. E. Mayne, Colonial Liaison Officer of the National Institute of Agricultural Engineering, there is a strong case for detailed local surveys of the power potential in all Commonwealth countries, as so much remains to be done in providing power to isolated communities and farms. There is a great need for more knowledge of water management and of the means to control the water table by artificial precipitation. He pointed out that in some countries cattle manure is used as fuel, whereas this could be returned to the soil if only adequate supplies of cheap electric power were available.

AERIAL SPRAYING STUDIES

R. F. HILL, A.F.R.AE.S., and R. T. JARMAN, M.SC., A.INST.P.
(*The Colonial Insecticides Research Institute, Porton, Wiltshire, England*)

This article describes the work of the Colonial Insecticides Research Unit at Porton on the aerial application of insecticides. Spraying equipment which would be useful for pest control in the colonies has been produced and tested here and some of this equipment has been used for experimental work by the Colonial Insecticides Research Unit based at Arusha in Africa.[1] *The work has been largely a continuation of that initiated by the Ministry of Supply Establishment, Porton, and much help has been given by personnel of that Establishment.*

AIRCRAFT can be used against pests regardless of the environment in which they live. Swamp or thick scrub, unsuitable for spraying with ground generators, present no insuperable difficulties to aerial treatment and where extensive areas are to be treated aerial spraying is frequently the only possible means of carrying out the work; it is also of value in comparatively small areas when the crops would be seriously damaged by ground equipment.

Aircraft types

Until the recent advent of aircraft designed specifically for spraying, the aircraft used have been selected mainly for their good flying characteristics and engine reliability. The principal details of those used in this research are summarised in Table 1.

The aircraft used for the initial work was the Avro Anson Mk. I illustrated in Fig. 1. It is a low-wing monoplane of pre-war design, powered by two 340-h.p. radial engines, and has a top speed of 120 m.p.h. with an all-up weight of 8,000 lb. A post-war development of this aircraft, the Avro XIX, has metal-covered wings, more powerful engines fitted with constant-speed propellers, and a larger fuselage, the top speed having increased to 150 m.p.h. at an all-up weight of 10,400 lb. The good flying characteristics and trouble-free record of service given by these two types of aircraft made them eminently suitable for work of this nature.

One of the smallest aircraft used is the De Havilland Tiger Moth. It is a two-seater biplane light aircraft powered by a 130-h.p., four-cylinder in-line engine, giving a top speed of 70 m.p.h. at a maximum weight of 1,825 lb., which was originally designed as a pilot training machine, but the ease with which it can be handled in the air, and the outstanding reliability of the Gipsy engine, have enabled it to be used successfully in many other roles, including dusting and spraying.

A more modern aircraft, with the same engine as the Tiger Moth, is the Auster J.1B, a high-wing monoplane with an enclosed cabin and two seats side by side (although load limitations do not always permit the carriage of a passenger when used on spray work). The Auster J.5G, a more powerfus version of the J.1B, with a Cirru Major 155-h.p. engine and practically double the range for the same payload, has also been used. Work with rotary wing aircraft has been carried out on a Westland S-51 Mk. I helicopter, a single-rotor, four-seat all-metal machine, powered by one 550-h.p. Alvis-Leonides engine.

Spray characteristics

The size of the droplet produced fo spraying is important. Large droplet fall rapidly under gravity to deposi near to the aircraft track, whereas small droplets can drift with the wind for miles.

In crop spraying it is desirable to spread the liquid uniformly over the crop and to have as little as possible drifting out of the field. However,

Fig. 1. The Avro Anson Mark I fitted with boom and nozzle equipment. It is a low-wing monoplane of pre-war design, powered by two 340-h.p. radial engines and has a top speed of 120 m.p.h.

TABLE 1

THE AIRCRAFT

Aircraft	*Avro Anson* I	*Avro XIX*	*De Havilland Tiger Moth*	*Auster J.1B*	*Auster J.5G*	*Westland S-51*
Type	Low-wing monoplane	Low-wing monoplane	Biplane	High-wing monoplane	High-wing monoplane	Helicopter
Engine(s)	2 × 340-h.p. Armstrong-Siddeley Cheetah X	2 × 450-h.p. Armstrong-Siddeley Cheetah XVII	1 × 130-h.p. Gipsy Major	1 × 130-h.p. Gipsy Major	1 × 155-h.p. Cirrus Major	1 × 550-h.p. Alvis Leonides
Insecticide load, lb. ..	1,500	2,000	350	300	450	650
Maximum weight of aircraft, lb.	9,450	10,400	1,825	2,250	2,450	5,250
Speed range, m.p.h. ..	80–120	90–150	45–70	50–70	50–80	10–70

although a more uniform deposit is obtained by breaking the liquid up into a large number of very small droplets, the hazard caused by the poisonous droplets drifting on to other crops is also increased, so for this work a compromise size of droplet, with a diameter between 100 and 500 microns (μ) is usually preferred.

In tsetse control operations it has been necessary to penetrate woodland areas; then smaller droplets which drift with the wind are useful. Successful operations have been carried out spraying a cloud of droplets with diameters ranging from 10 to 100μ.[2]

All the aircraft installations tested have produced a range of droplet sizes. It is common to describe a spray in terms of both a mean droplet size and a measure of the uniformity of size of the droplets. The mean used was the volume median diameter (v.m.d.), which divides the spray into two parts with half the volume being in droplets with diameters larger than the v.m.d. The measure of uniformity used was the range of droplet sizes in which half of the volume is found and is bisected by the v.m.d. Table 2 gives the values of the v.m.d. and the range of the sprays produced by the equipment tested.

To measure the sizes of the droplets produced the aircraft was flown straight and level, in a cross-wind direction, as low as safety permitted, over a slightly contoured surface of short grass and a dyed liquid was emitted for a timed interval of about 30 sec. Sampling surfaces were laid on the ground, in lines along the forecast wind direction and in the later experiments a mast was erected 300 yd. downwind, carrying equipment to sample the droplets that were drifting away. Magnesium oxide-coated glass plates, siliconed glass plates and sheets of absorbent filter paper were used to sample the ground deposits; cascade impactors and sheets of wire gauze mounted on the mast sampled the air-borne droplets. The relation between the droplet size and the stain or pit produced on the sampling surface by the dyed liquid was found in subsidiary experiments. From these calibrations, and the measurements of the stains and pits produced in the field trial, the sizes of the droplets produced by the spraying equipment were computed.

The following liquids were used:

(*a*) T.P. 5007, which is a 10% solution of DDT in a mixture of one part of fuel oil and four parts of power kerosene, is a practical insecticide formulation.
(*b*) A DNC solution containing 20% of dinitro-ortho-cresol, 72% of Iranolin kerosene extract bottoms and 8% of Iranolin 2241, has been used for locust eradication.
(*c*) Dyed tap water.
(*d*) ASPA 21, a spindle oil of low volatility and viscosity.
(*e*) Power kerosene, a cheap and volatile solvent which would evaporate, producing smaller droplets.

The water was dyed with 1% croceine scarlet and the rest with waxoline red.

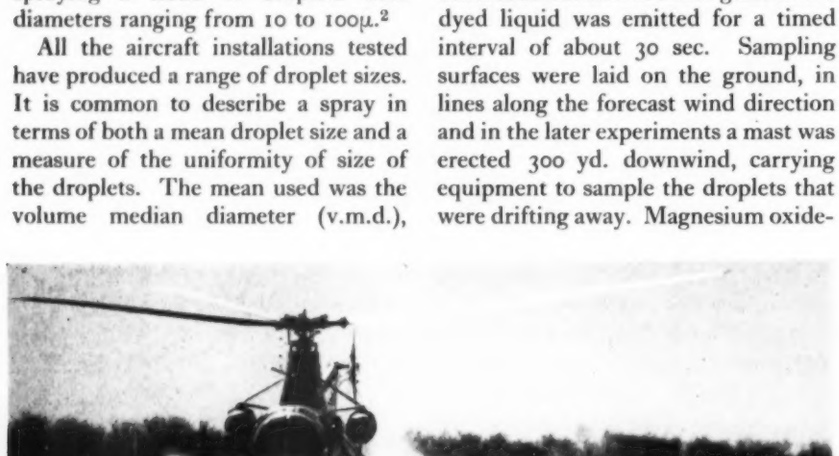

Fig. 2. The Westland S-51 helicopter, fitted with spray boom and external insecticide tanks, is shown spraying from a low level

Spraying equipment

A number of atomisers, which varied in complexity, have been tested and details of their performances are given in Table 2. In the simplest type, the vertical emission pipe, the liquid flowed out under gravity to be shattered into droplets by the air stream. In an atomiser modelled somewhat on the Todd insecticidal fog applicator, the liquid was pumped out of a perforated tube inside the exhaust pipe and atomised by the exhaust gases flowing past. Next, pressure nozzles,

Fig. 3. The Auster J.1B aircraft, fitted with multiple rotating disks, is shown in action during the assessment trial

which produced a high-velocity jet of liquid of microscopic thickness, were introduced. A number of these were mounted on a boom hung under the aircraft, and the sheets of liquid were broken into small droplets by the airstream. The maximum friction, due to relative motion of the sheet and the airstream, was obtained by pointing the nozzles forward, and then smaller droplets are produced than if the nozzles are pointed downwards or backwards.[3] In rotary atomisers the liquid is fed to a rapidly rotating head and the film formed at the periphery is shattered by the centrifugal force and forces due to the relative motion of the sheet and air. The centrifugal force acts radially and the relative motion is tangential, being produced by the rotation of the sheet and the forward motion of the aircraft.

In the laboratory, with small emission rates, sprays with an almost uniform droplet size have been produced for experimental work,[4] but in aerial spraying larger emission rates are desirable, and the high relative speed of the liquid and air has been used to produce very useful atomisers for fitting to slow, light aircraft. Three different types of rotary atomiser termed the brush, cage and disk respectively, that have been used for aerial spraying in recent years, have been tested. The head of the rotary brush consists of a number of wires which radiate from a hub, resembling the brushes used by chimney sweepers, and the rotating cage is the name given to a rotating cylinder of wire gauzes, in which the insecticide is fed from the axis of the cylinder. The rotating disks consist simply of a number of disks mounted coaxially.

Vertical emission pipe.—An Avro XIX aircraft with two 100-gal. insecticide tanks, mounted side by side between the spars, was fitted with a vertical emission pipe to each tank. A short pipe incorporating a valve projected through the aircraft skin from the base of each tank, terminating in a flange to which was bolted a 3-in.-dia., light-alloy tube, 11 in. long, tapering to 2½-in. dia. at the lower end to suit a standard Porton variable orifice.[5] This device works on the same principle as the iris in a camera and by varying the size of the opening some control over the rate of flow can be obtained. Rates of flow varying from 30 to 100 gal. per min. were obtained. To obtain a constant rate of flow, the orifice mechanism was linked by a system of rods and ball joints to a ball float inside the tank, so that as the liquid level fell the orifice was opened sufficiently to maintain the selected flow rate. To assess the performance of this spraying installation, DNC was sprayed at a rate of 98 gal. per min. from the aircraft flying at 120 m.p.h. The v.m.d. of the droplets deposited on the ground was 310μ.

Exhaust atomiser.—The exhaust-smoke-type atomiser developed from the Todd insecticidal fog applicator was fitted to a 3-ft. 6-in.-long extension to the port engine exhaust pipe of the Avro XIX aircraft and one of the insecticide tanks mentioned above was used. The insecticide was delivered to the atomiser under pressure by a gear-type pump driven by an adjustable pitch windmill set to rotate at 1,000 r.p.m., and giving an output of 5 gal. per min., when flown at 120 m.p.h. It was necessary to remove the carbon that formed in the perforated tube to ensure that the flow rate was not continually being reduced. The v.m.d. of the droplets deposited on the ground was found to be 80μ.

Boom and nozzles.—Boom and nozzle type equipments were fitted to the Anson I and the Auster J.5G aircraft. In the first installation on the Anson the boom of 52-ft. span carried 24 Porton type flat spray ceramic nozzles, size 'O', which faced forwards. The insecticide was pumped through these at a pressure of 150 lb. per sq. in. by a gear-type pump, driven in turn by a four-bladed windmill rotating at 2,000 r.p.m. when the aircraft was flown at 120 m.p.h. The largest tank that could be passed through the entrance door carried only 60 gal. of insecticide, so to carry the maximum amount of insecticide two 60-gal. tanks and two 30-gal. tanks were installed in the cabin. The 60-gal. tanks were mounted on cradles between the wing spars and to keep the aircraft's centre of gravity within permissible limits the 30-gal. tanks were fastened above and connected to the larger tanks by 6-in.-bore pipes. The filler caps projected through the cabin roof, enabling the tanks to be filled without any danger of fumes or spilt insecticide entering the cabin. It was found that when the aircraft was flown at 120 m.p.h. spraying T.P. 5007 at 11½ gal. per min. the v.m.d. of the droplets deposited on the ground was 70μ. This aircraft was afterwards used successfully in experiments to control tsetse flies in Africa.[6]

Subsequently, to reduce the drag, a streamlined boom with a span of only 28 ft. was made. A wooden streamlined fairing at the rear of the boom allowed the nozzles to be pointed in any direction, other than rearwards, by rotating the boom. The boom was mounted parallel to the ground at a distance of 10 in. below the fuselage, each boom tip being 26 in. below the corresponding wing. Since the presence of turbulent air behind each engine nacelle was found to lead to contamination of the aircraft, nozzles were omitted from this section of the boom. The insecti-

cide storage tanks were retained, but the piping was rearranged in such a manner that either or both pairs of tanks could be selected in flight. Contents gauges were fitted to both sets and an adjustable pressure-relief valve and pressure gauge were installed in the cabin to enable an observer to make adjustments during flight. Size 'O' nozzles (28) were fitted and the emission rate of T.P. 5007 at a pressure of 150 lb. per sq. in. was 10 gal. per min. The droplets deposited on the ground had a v.m.d. of 50μ.

The Auster J.5G was a typical conversion of this type of aircraft supplied by the Auster Company for boom and nozzle spraying, the rear seats having been replaced by a 45-gal. insecticide tank. A windmill-driven pump feeds the liquid to the 17-ft. boom under pressures of 40 to 60 lb. per sq. in. at rates varying from 10 gal. per min. to 25 gal. per min. Hollow-cone-type swirl nozzles (20 in number) with $\frac{3}{32}$-in.-dia. orifices facing aft were mounted at equal intervals on the boom. The airflow in the wake of the boom caused some of the spray to be drawn upwards and deposited on the rear of the boom, from which it was blown off in irregular ligaments. The spray emitted from four nozzles which were immediately under the fuselage caused heavy contamination of the underside of the aircraft and by removing these the contamination was eliminated. The performance of the equipment was assessed, using three different liquids. It was found that sprays with v.m.d.s from 190 to 490μ could easily be obtained at emission rates of 7 to 10 gal. per min., with the aircraft flying at 70 m.p.h.

A new boom made of streamline section with the same span, 32 size 'O' nozzles facing forward and placed outboard at 4-in. intervals, leaving clear the central portion of 3 ft. underneath the fuselage, was found to have neither of the shortcomings found with the previous boom. With the aircraft flown at 70 m.p.h., T.P. 5007 and water have produced sprays with v.m.d.s of 150 and 240μ respectively.

Recently a 17-ft. spray boom, carrying size 'O' nozzles, and two 50-gal. insecticide tanks were fitted to a Westland S-51 Mk. I helicopter, as shown in Fig. 2. At first the insecticide feed pump was directly driven by the engine through one of the accessory drive positions. However, as the aircraft was also being flown for other purposes, excessive wear of the pump mechanism took place, and so a hydraulic drive system was installed, which enabled the insecticide pump to be isolated from the engine and turned off when the aircraft was not being used for spraying. This was done by fitting a hydraulic pump to the accessory drive in place of the insecticide pump and taking the power from the former to drive a hydraulic motor, which in turn operated the insecticide pump. The boom was made of 1½-in.-O.D. steel tube and 25 nozzles were mounted at 8½-in. intervals. It can be rotated to allow the jets to point in any direction.

Rotary atomisers.—A single rotary brush unit, manufactured by Independent Crop Dusting Incorporated, of California, U.S.A., was mounted under the fuselage of the Avro XIX aircraft and driven by a two-bladed windmill of 22-in. diameter. A light-alloy casting formed a housing for the shaft and was constructed in such a manner that the liquid could be fed on to the centre of the wire brushes, which were 10 in. in diameter and had strands of 0.005-in.-dia. wire. To ensure a uniform rate of flow from the tank to the rotary brush unit the tank was made airtight and the air-inlet tube arranged to extend to within ½ in. of the tank bottom. Assessment trials were made, spraying T.P. 5007 from the aircraft, which flew at 120 m.p.h. With an emission rate of 12 gal. per min. the v.m.d. of the droplets deposited on the ground was 120μ, and by reducing the emission rate to 7 gal. per min. this was reduced to 90μ. A. W. A. Brown has used rotary brush units, fitted to a Dakota aircraft, for successfully spraying mosquitoes and black flies in Canada.[7]

The rotary-cage-type atomisers were installed on a De Havilland Tiger Moth, one atomiser being mounted on

TABLE 2

SPRAYING SYSTEMS

Atomiser	*Aircraft*	*Details of installation*	*Airspeed, m.p.h.*	*Liquid used*	*Emission rate, gal. per min.*	*v.m.d., μ*	*Range, μ*
Emission pipe	Avro XIX	Vertical emission pipe, 2½ in. dia.	120	DNC	98	310	290
Exhaust smoke	Avro XIX	Modified Todd insecticidal fog applicator fitted to exhaust	120	T.P. 5007	5	80	—
Boom and nozzle	Anson 1	24 size 'O' nozzles;* pressure 150 lb./sq. in.	120	T.P. 5007	11½	70	40
		28 ,, ,, ,, ,, ,, ,,	120	,, ,,	10	50	20
	Auster J.5G	20 nozzles, dia. $\frac{3}{32}$ in.; pressure 20 lb./sq. in.	70	T.P. 5007	9	190	90
		16 ,, ,, ,, ,, ,, ,,	70	ASPA 21	7½	490	400
		16 ,, ,, ,, ,, ,, 40 ,,	70	Power kerosene	10	210	120
		32 size 'O' nozzles; pressure 55 lb./sq. in.	67	T.P. 5007	12	150	130
		16 ,, ,, ,, ,, 60 ,,	70	,, ,,	6	140	150
		32 ,, ,, ,, ,, 55 ,,	70	Water	9½	240	130
Rotary brush	Avro XIX	1 unit under fuselage. 10-in.-dia. brush of 0.005-in.-dia. wires. 2,500 r.p.m.	120	T.P. 5007	12	120	60
			120	,, ,,	7	90	50
Spinning disks	Auster J.1B	1 unit under each wing tip. 12 disks each, 10½ in. in dia., at 4,000 r.p.m.	70	DNC	11	110	100
Spinning cage	Tiger Moth	1 unit on each lower wing tip, 4 in. in dia., rotating at 16,000 r.p.m.	75	T.P. 5007	6	50	30

* Size 'O' nozzles are Porton flat spray nozzles with cross-sectional area of 0.78 mm.².

each wing tip. The insecticide solution was drawn from a storage tank carried in the front cockpit and delivered to each unit by a windmill-driven centrifugal pump mounted under the fuselage. The atomiser, which was driven at approximately 15,000 r.p.m. by an 18-in.-dia. windmill, through a $2\frac{1}{2}$ to 1 ratio pair of belt-driven pulleys, consists of a number of 4-in.-dia. fine gauze cylinders, mounted on a sleeve 14 in. long with a number of radial holes, through which the insecticide flowed to be centrifuged off the gauze cylinder. It was found that flying at 75 m.p.h., spraying T.P. 5007 at 6 gal. per min, the v.m.d. of the droplets produced was approximately 50μ. It has been reported[8] that aircraft equipped in this way have been used with great success for spraying cotton in the Sudan.

Multiple rotating disks have been installed on a Auster J.1B by Fisons Pest Control Ltd. for the Desert Locust Control Organisation and the aircraft so equipped is shown in Fig. 3. The atomising devices were suspended from each wing near the tip, thus ensuring that no contamination of the aircraft took place. Each consisted of 12 circular metal disks, $10\frac{1}{2}$ in. in diameter, driven by a 19-in.-dia. four-bladed metal windmill mounted at the front of the pod. When flown at 70 m.p.h. the windmill rotated the disks at approximately 400 r.p.m. The liquid was fed on to the centre of the disks through radial holes in the mounting sleeve and centrifuged off the outer edge as a spray. In the Auster J.1B aircraft the petrol is carried in a tank between the dashboard and the firewall; consequently it was possible to use the space provided for petrol tanks in the wing roots for the insecticide tanks, each 15-gal. tank being made of reinforced fibreglass to avoid corrosion problems. An electric actuator operated both the windmill brake and the on-off cock together in each unit, and as the tanks were not interconnected it was possible to use the units individually. Flying at 70 m.p.h., spraying DNC solution at a rate of 11 gal. per min., it produced a spray in which the v.m.d. of the droplets was 110μ.

Acknowledgements

We would like to thank Mr. R. B. E. Stubbs, who has been closely associated with us in this work and to express our appreciation of the help and encouragement given to us by Mr. S. H. Fryer and Dr. A. B. Hadaway.

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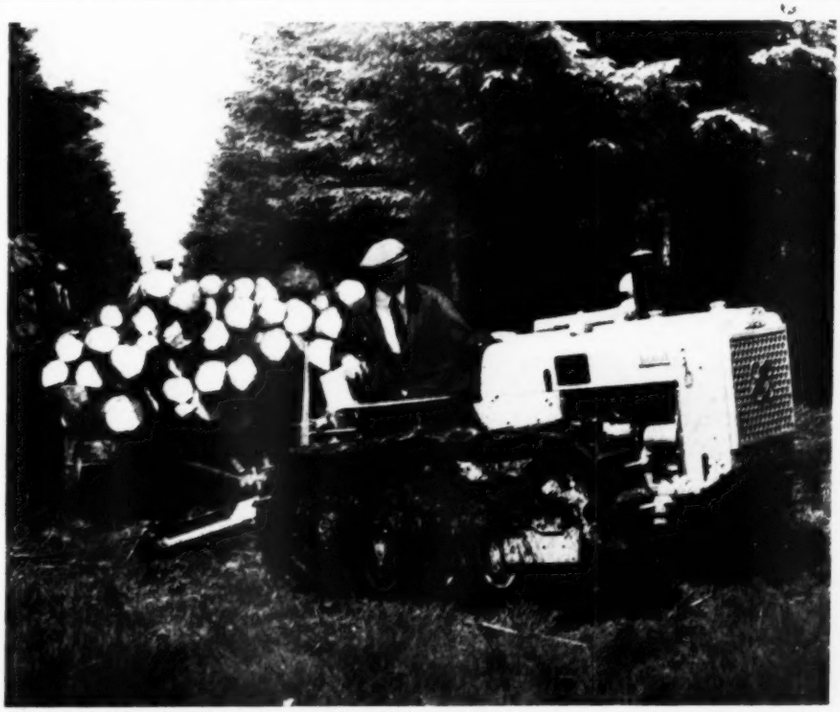
A New Crawler Tractor

The Bristol '25' crawler tractor is described by its makers, Bristol Tractors Ltd., as the lightweight crawler with the heavyweight pull and as such it appears to provide the answer to the world's declining population of elephants, since it is so suitable for work in primary forests and secondary jungles, and the quarries and swamps of the tropics. It can operate on diesel oil or kerosene and will claw into the ground to exert a drawbar pull of over 2 tons, *e.g.* a big locomotive which has a drawbar pull of 20 tons can haul loads of 800 tons or more. As it weighs only 2 tons, it can be taken by air into mountainous or otherwise inaccessible country, such as is found in the interior of New Guinea, Borneo, Burma or China, or in arctic regions or desert wastes.

The Bristol '25' has a three-cylinder engine with 23 b.h.p. with diesel oil or four-cylinder engine with 22 b.h.p. with kerosene. It is mounted on two sturdy caterpillar tracks and may be ordered with nine different track centres, varying from 37 in. up to $61\frac{3}{4}$ in. overall, according to special requirements. It may thus be used for cultivating close- or wide-planted crops, for work in confined spaces, or up, down, or across steep slopes, according to the width of track ordered.



The Bristol '25' tractor is suitable for heavy haulage in confined spaces, e.g. pine forests or tropical jungles

For this reason the machine has a wide range of practical applications. It could equally well be used for hauling tea up, down or across steep hillsides, or loads of pineapples in trackless peat swamps; it could be used for the cultivation of hilly moorlands or the reclamation of eroded lands by gully-plugging; or it could be employed in

(Continued on page 65)

ULTRA-LOW-VOLUME SPRAYING IN AFRICA

G. J. ROSE

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The past few years have seen a great extension in the use of the ultra-low-volume method of applying fungicides, insecticides and weedkillers in Africa. Planters and research bodies have been quick to realise the advantage of this method of spray application, which combines a reduction in the water required for spraying, a saving in the active chemical itself, and a reduction in the amount of time and labour required for the completion of operations.

DURING the past year a good deal of interesting development work has been carried out on a wide range of crops grown in different parts of Africa. Spraying experiments have covered coffee, cereals, wattle trees, orchards, cotton and bananas.

Coffee spraying

The East African Arabica coffee industry is one of the most progressive plantation industries in the world and the high price which has been paid for their crop over the past few seasons has enabled the planters to indulge in a good deal of mechanisation which would perhaps not have been possible in a slower market. Since applications of copper fungicides at least twice every season are obligatory for control of *Hemeleia vastatrix* (leaf rust) and abnormal leaf fall, planters have for a long time been conscious of the deficiences of a high-volume spraying system. They have therefore very readily accepted and undertaken a great deal of development work with the ultra-low-volume system. A good many planters have equipped themselves with ultra-low-volume machines which depend upon the use of a rotary atomiser and a powerful air blast to produce small, even droplets of spray and to deposit those droplets of the spray on the under-leaf surfaces where they are most effective. It was discovered, by employing the Rubeanic leaf print technique, that an excellent fungicidal cover could be obtained when a total of approximately 10 gal. per acre of a water-based copper fungicide was applied. In most of the work with a water-based spray a fairly coarse droplet in the order of 200-micron mass median diameter was employed.

Hemeleia. — For the control of *Hemeleia*, 2½ lb. of a proprietary copper fungicide containing 50% copper was added to every 35 gal. of the water.

Following the successful use of an oil-based colloidal copper to control banana-leaf spot in the West Indies, initial experiments have been laid down to assess the value of these materials against *Hemeleia*. When applied to coffee, 1½ lb. of a concentrate of colloidal copper oxychloride containing 40% copper in a non-phytotoxic white oil were mixed with 12 gal. of a non-phytotoxic oil and applied at a rate of 3 gal. per acre total spray liquid. It is felt that this rate per acre may be reduced when further experience has been gained and it is hoped that the non-phytotoxic white oil will give the fungicide a greater persistence and also will act as a catalyst to the fungicidal properties of the copper oxychloride.

Antestia.—Two important insect pests of Arabica coffee in East Africa have been tackled employing the ultra-low-volume technique, *Antestia*, a plant bug, which moves about actively in the coffee bush, was very effectively controlled after an application of ¾ lb. of DDT per acre in 8 gal. of water. In future, drift spraying experiments will be carried out against this pest, applying various quantities of Malathion, Endrin, and DDT in a white oil using a total of 1 gal. of spray per acre.

Leucoptera coffiella.—The coffee leaf miner (*Leucoptera coffiella*) provided the subject for a most interesting experiment with the new material Diazanon. The most effective treatment was the application of 0.6 lb. of a 60% emulsifiable concentrate in 10 gal. of water applied at a total rate of 8 gal. per acre blast spraying. A population of 72 living larvae per 100 leaves sampled was reduced to 15 after five days. It was felt that this reduction in population might be sufficient to enable the parasites of *Leucoptera* to dominate the rest of the population. Although this trial was by no means conclusive it suggested that a smaller quantity of Diazanon applied at a more timely moment, or half the quantity of Diazanon applied twice, might provide a very satisfactory method of completely controlling this pest. Further work is being carried out to ascertain more details of the life cycle of the pest in order to try and determine just when the applications should be made.

Deficiency of minor elements.—In certain regions of East Africa (notably the northern province of Tanganyika) the Arabica coffee is beginning to suffer from a deficiency of certain minor elements. The most important of these appear to be manganese and zinc. Experiments have been in progress for some time to determine the possibility of obtaining a response when these elements were applied to the foliage of the coffee through high-volume equipment. Since it seems likely that the ultra-low-volume system will become increasingly popular on coffee estates, it was considered worth-while discovering whether such equipment would be suitable for the application of minor elements.

A restorative minor element treatment probably demands the applica-

A portable Micron sprayer, Model 150, being used to apply endrin to control Stephanoderes hampeii *in Robusta coffee*

tion of a very specific quantity of that element per acre. It was therefore decided to apply manganese and zinc to coffee at approximately ten times the normal concentration to see whether the foliage of the coffee would suffer any scorch after the application of such a concentrated spray. Magnesium sulphate (14 lb.), zinc sulphate (7 lb.) and slaked lime (12 lb.) were all mixed with 10 gal. of water, and this mixture was applied to one acre of multiple-stem coffee in the northern province of Tanganyika. Inspection several weeks after the application showed that this mixture when applied through an ultra-low-volume sprayer had produced no scorch and all the foliage appeared to be in excellent health. It may therefore be concluded that ultra-low-volume spraying is satisfactory.

Collatotrichium coffeana. — Coffee berry disease is becoming an increasingly important disease in the White Highlands of Kenya; and it has been suggested that the small persistent droplets, and the even distribution of these droplets, which are a feature of an ultra-low-volume sprayer equipped with a rotary atomising system, may make it a very useful tool for the application of mercurial fungicides to control coffee berry disease. Experiments are, therefore, being laid down to provide this information.

Stephanoderes hampeii.— Growers of Robusta coffee in Uganda and the Belgian Congo spray annually in order to control a small beetle, *Stephanoderes hampeii*. The female adult is very active after the flower has fallen and causes most of the damage,when pricking the young cherry with her ovipositor while searching for a suitable place to lay her eggs. It has been discovered that an application of 250 g. of technical Endrin per acre just after the big crop flower has fallen will provide excellent control of this pest. Experiments have been laid down applying this quantity of Endrin in 1 and 2 gal. of an oil per acre. Since this pest moves about actively, a modified drift-spraying or a long range blast-spraying technique was employed.

Spraying equipment

The biggest problem to be faced in the choice of machinery for use in Robusta coffee plantations is presented by the very rough ground conditions and the lack of clearance in the rows of mature coffee. Two types of equipment are being adopted for this work: either portable equipment, which may be carried by one or two men and moved down the rows enabling four or five rows to be treated from one row, or the larger tractor or truck-mounted machines, which have an air blast capable of a positive throw of up to 50 yd. under still air conditions. In order to accommodate such machines the more progressive plantations are cutting roads through their blocks of coffee at these intervals. With a view to future spraying requirements the Robusta planters are laying down all young coffee leaving suitable tracks at 50-yd. intervals.

Cereal spraying

A good many experiments have been carried out over the past two seasons to determine the suitability of the ultra-low-volume sprayer for the application of selective weed-killers to standing cereal crops. The results obtained have been quite astonishing. An ultra-low-volume sprayer was mounted upon the hydraulic lift of any of the popular range of tractors or used as a trailer machine with a low-mounted outlet containing a rotary atomiser directed at 90° to the line of travel so that a strong beam of air filled with small spray droplets was driven along the surface of the ground. It was discovered that the application of 1 pt. per acre of the butyl ester of 2,4-D (80%) diluted with 1 gal. of commercial diesel oil would give an excellent control of even very resistant broad-leaved cereal weeds without causing damage to fully tillered wheat. Application of 2 pt. per acre of a 50% mixed ethyl and *iso*propyl ester of 2,4-D, in 1 gal. of diesel oil, were very effective against broad-leaved weeds.

Employing this weedkilling technique, it is possible to treat 15–20 acres of wheat per hour and to treat 35 acres of wheat before refilling becomes necessary. The machine is moved through the crop at 15-yd. intervals. This large swath coupled with the low volumes of liquid per acre, is responsible for the high speed of application. All spray deposited beyond 15 yd. is considered as overlap. With the outlet in the low position the strong air blast produced by the machine tends to turn over the leaves of the weeds so that the droplets of spray are deposited upon the lower surface where they have the most effect.

Maize

It was decided to extend this weed-killing technique to the maize crop and again the results obtained have been very striking.

Pre-emergence spraying.—It was held in question whether the ultra-low-volume sprayer would be suitable for applying selective weedkillers as a pre-emergence treatment. Previously it was always considered that for a successful pre-emergence kill the

weedkiller should be applied in a minimum of 20 gal. of water per acre and it was also proved that such treatments are more effective when carried out on damp land. Using the low-volume machine, the application of 2½ pt. per acre of a 50% mixed ethyl and *iso*propyl ester of 2,4-D applied in 3 gal. of water per acre gave extremely good results even though the treatments were made when the land was practically dried out and it was at least three days since the last appreciable shower of rain. Well over a day elapsed before there was further rain. The applications themselves were made on a hot sunny afternoon in the White Highlands of Kenya.

Post-emergence spraying.—It was doubted whether maize, 5 in. high, would be capable of standing up to the severity of an application of a selective weedkiller diluted with diesel oil. Numerous treatments were carried out, but the most effective was the application of ¾ pt. of 80% butyl ester 2,4-D in 1 gal. of diesel oil per acre. Although the maize appeared set back in the first few days it has since fully recovered and promises to crop well.

Many of the oil-based selective weedkilling treatments were carried out upon the farm of Mr. W. J. Dawson, Memzie, N'Joro, Kenya, whose enthusiasm for experimental work on a large scale has allowed us to extend our knowledge of weed-killing in wheat and maize. Throughout the weedkilling work a droplet size of 60-micron mass median diameter was employed.

Some interesting work was carried out for the control of army worm, which was attacking lucerne and grassland and also, in another district of East Africa, maize. With an ultra-low-volume sprayer mounted upon the hydraulic lift of a Ferguson tractor, it was possible to treat 80 acres of maize in 2½ hours' drift spraying on a 50-yd. swath. In both cases a treatment of 2½ pt. of a 25% DDT emulsifiable concentrate were applied in ¾ gal. of diesel oil per acre.

Wattle

Earlier this year very interesting experiments were carried out to determine the effectiveness of an ultra-low-volume sprayer in the application of insecticides to control a Lymantrid caterpillar attacking wattle trees up to 65 ft. high. It was discovered that a high degree of control could be obtained when applying ¾ lb. of Endrin in 3 gal. of diesel oil per acre. The sprayer was moved down alternate rows of wattle.

Orchard spraying

Dissatisfied with the conventional leaf print technique for detecting cover upon the leaf surfaces, it was decided to search for a fluorescent material that could be incorporated with a spray and which would fluoresce under an ultra violet lamp, to show the actual spray deposit upon the leaves themselves. Several materials were tried, such as Fluorescene (sodium). Unfortunately these materials would only give the desired effect upon filter paper where they apparently formed some sort of adsorbate. A paper by R. B. Sharpe, of the N.I.A.E. at Silsoe, gave the answer. Mr. Sharp had tried a wide range of materials and found zinc-8-hydroxyquinolinolate gave one of the most satisfactory results. This material was incorporated in sprays when weedkilling, coffee spraying, and orchard spraying. Employing this technique, it was discovered that 10 gal. of a water-based spray would give an excellent cover of all surfaces of the foliage of Kenya apple orchards.

Cotton

Ultra-low-volume spraying equipment has proved very effective in the past for the control of cotton pests in the Sudan. Research bodies in Egypt have been looking for equipment based upon the same principle for use in the smaller cotton fields of their country. Experiments are at present being carried out employing two-men portable low-volume sprayers applying Toxophene and some cases DDT sprays in a total of 1 gal. of a non-phytotoxic oil per acre. A drift-spraying technique is being adopted and it is hoped that it will be possible to obtain good control of their major pest, the cotton-leaf worm.

Bananas

The use of ultra-low-volume equipment for the application of oil-based colloidal copper sprays has already been adopted in French West Africa as the result of previous work carried out in the West Indies.

Successful control of pests, weeds and diseases with low rates of chemical and diluent per acre depends almost entirely upon obtaining an even cover of the surfaces to be protected. One of the most satisfactory ways of producing this cover is to produce small, even droplets of spray from a rotary atomiser and employ a powerful air blast to deposit these droplets on the target.

It must be said that the broad-minded, seeking approach of research bodies, chemical manufacturers and planters, has been responsible for the early adoption of this type of equipment on the African continent.

A Micron 'Meg' is here seen spraying Robusta coffee in the Belgian Congo

OLIVE-LEAF SPOT DISEASE IN CYPRUS AND ITS CONTROL

G. P. GEORGHIOU

(*Plant Protection Service, Department of Agriculture, Nicosia*)

Olive-leaf spot is of major economic importance in some parts of Cyprus. Losses suffered may be as great as those from olive fly (Dacus oleae *Gmel.*) *and* Rhynchites ruber *Fairm. In this article trials carried out during* 1955 *and* 1956 *are described, which have shown that the disease may be controlled satisfactorily by applications of Bordeaux mixture.*

THIS disease, caused by the fungus *Cycloconium oleaginum* Cast., is characterised by circular spots on the upper surface of the leaves. These spots are dull green to almost black in colour and 2 to 10 mm. in dia. They are most noticeable during spring and early summer, at which time the heavily affected leaves drop to the ground. The lesions are most abundant on the foliage in the lower parts of the trees, and many of the twigs in these parts may be completely defoliated. Defoliation may occasionally be so severe, especially in thickly planted groves, that only a few leaves will remain on the trees during the summer and autumn months. As a result the vitality of the tree is reduced and this condition affects adversely the amount of fruit set in the following spring.

A few of the less severely affected leaves usually remain on the tree until the following winter. With the occurrence of humid weather in October–November, the spots present on these leaves enlarge, producing a large quantity of spores. These are washed down by rain and give rise to new infections during the winter and early spring. The new spots actually become visible to the eye during late winter, but they are seldom noticed until late spring and early summer, when the heaviest leaf drop takes place.

In the past, various authors have attempted to correlate the occurrence of the disease in severe form to the texture of the soil, to cultural practices or to the amount of annual precipitation in the area. In Cyprus the disease is most prevalent in the general area from Strovolos and Nicosia eastward to Kondea and Famagusta. It has also been noticed in severe form during 1954–55 and 1955–56 at Meneou and Limassol (average annual rainfall 12–20 in.). It has not been observed along the northern coast, which receives an average of 20–28 in. of rain a year.

A report from Cyprus in 1935 states that control measures against this disease are not often necessary or profitable.[1] Recent observations, however, have indicated that, although the disease may not be of economic importance over most of the island, a large number of commercial groves in Strovolos, Nicosia, Kondea, Meneou and Limassol have suffered heavy losses from it in recent years.

TABLE 1

MONTHLY RAINFALL AT NICOSIA DURING THE PERIOD OF THE EXPERIMENT

Month	*Rainfall, in.*	*No. of days of rain*	*Greatest fall in one day, in.*	*Day of greatest fall*
1955				
September ..	—	—	—	—
October ..	0.46	2	0.41	31
November ..	1.54	10	0.55	21
December ..	3.84	14	0.88	6
1956				
January ..	2.86	15	0.50	7
February ..	2.04	9	0.71	27
March ..	1.62	8	0.76	21
April	0.32	3	0.15	1
May	1.09	4	0.48	6
June	0.18	1	0.18	29
July	—	—	—	—

Control experiments

Bordeaux mixture has been recommended for use against the olive-leaf spot as early as 1898.[2] There has, however, been considerable divergence of opinion as to the best time for applying these sprays. Some workers suggested winter and early spring; others May and July; and still others summer applications.

Recent work in California[3] and in Israel[4] indicated that best control of the disease may be obtained by applying the spray just before the protracted rains begin in the autumn or early winter. In view of the similarity of climate in Cyprus to that of California and Israel, it was decided to carry out a timing experiment with Bordeaux mixture with emphasis on treatment in late October, just before the onset of the rainy season. The experiment was carried out during the 1955–56 season on olives of the ' Ladoelia ' variety in a large commercial grove in Nicosia. Each plot consisted of six to ten large trees in one row, the distance between rows being about 80 yd. Bordeaux mixture (10–10–100) was applied with a high-volume power sprayer at 300–400 lb. pressure per sq. in. Some plots were sprayed once, and others twice. There were four replications of each treatment. The monthly rainfall at Nicosia during the period of the experiment is shown in Table 1. Sampling to assess the efficiency of the treatments was carried out during the second week in July 1956. Eight twigs were received at random from each tree at shoulder height, and the number of spots on the leaves was recorded. Leaves with more than 10

Olive leaves affected by Cycloconium oleaginum, *showing the characteristic circular spots*

spots were put in the 10-spot category. Some 800 leaves were examined from each plot.

TABLE 2

CONTROL OF *Cycloconium* LEAF SPOT BY VARIOUS TREATMENTS OF BORDEAUX MIXTURE DURING 1955–56

Dates of application	*Average number of lesions per 100 leaves*	*Reduction in the incidence of leaf spot, %*
20 October	2.9	92
20 October and 22 November	3.6	91
20 October and 29 December	1.8	95
20 October and 21 January	2.0	95
20 October and 21 March	2.3	94
22 November	2.6	93
29 December	6.8	82
21 January	32.1	16
21 March	31.3	18
Control	38.2	—

The dates of application of Bordeaux mixture, the average number of spots per 100 leaves examined and the percentage reduction in the incidence of leaf spot in the plots are given in Table 2. The distribution of the disease in the various parts of the grove presented large variations and this has made it impossible to analyse the results statistically. It will be observed, however, from Table 2 that over 90% control of the disease was obtained in plots that received one treatment on 20 October or 22 November. Practically no control was obtained when the treatment was given in late January or late March. The best control (95% reduction in leaf spot) was obtained when the 20 October treatment was supplemented by a second treatment on 29 December. However, a second treatment may not be necessary except in years of abundant rainfall.

An olive tree that has been treated with Bordeaux mixture and has retained most of its foliage

Varietal susceptibility

It has been observed that the incidence of the disease varies greatly on different varieties. Counts of spots carried out on olive trees at Famagusta and Kondea are shown in Tables 3 and 4 respectively. These indicate that the common local variety, 'Ladoelia', is more susceptible to olive-leaf

TABLE 3

DEGREE OF INFECTION OF OLIVE VARIETIES BY *Cycloconium oleaginum Cast.* AT THE GOVERNMENT NURSERY GARDEN, FAMAGUSTA, DURING 1954, 1955 AND 1956

Variety	*No. of trees examined*	*Spots per 100 leaves (average of 1954*, 1955† and 1956‡ counts)*
Morellona	1	0
Morinello	1	0
St. Agnes	1	0
Shemlali	3	0.02
Cucco	1	0.17
'Spanish'	1	0.17
Suri	2	0.55
Manzalino	2	0.77
Ascolano dura	1	1.5
Sevillano	1	4.37
Volou	1	65.87
Makhavia	2	78.67

* 30 April, 1954.
† 3 May, 1955.
‡ 22 June, 1956.

Olive branches showing severe defoliation as a result of Cycloconium oleaginum

spot in comparison to a number of introduced varieties.

In addition, on the basis of these limited observations, the introduced varieties, Morellona, Morinello, St. Agnes, Shemlali, Ascolano, ' Spanish ', Cucco, Ascolani dura, Suri and Manzalino, may be considered as non-susceptible, Sevillano as moderately susceptible and Volou, Makhavia, Kalamon and Adrouppa as particularly susceptible to this disease.

Summary and conclusions

The olive-leaf spot disease is of economic importance in certain areas of Cyprus and control measures against it are essential. In experiments carried out during 1955–56 with 10–10–100 Bordeaux mixture, one treatment applied on 20 October reduced the incidence of the disease by 92%. Treatments applied in late January and late March had little or no effect on the disease. A second treatment applied at different periods in addition to the treatment of 20 October increased the efficiency of the first treatment only slightly. Best control (95%) was obtained when the treatment of 20 October was supplemented by a second treatment on 29 December. A second treatment may not, however, be necessary, except in years of abundant rainfall.

Counts on the incidence of leaf spot on various olive varieties indicated that the common local variety, 'Ladoelia', is more susceptible to this disease than a number of other introduced varieties.

TABLE 4

DEGREE OF INFECTION OF OLIVE VARIETIES BY *Cycloconium oleaginum Cast.* AT KONDEA* IN 1955†

Variety	*No. of trees examined*	*Spots per 100 leaves*
Ladoelia	4	520.9‡
Kalamon . .	3	44.7
Adrouppa . .	3	36.2
Morinello . .	3	1.7
Shemlali	5	0
Ascolano denera . .	2	0
' Spanish ' . .	1	0

* Cyprus Vineyards Ltd., Kondea.
† 21 April, 1955.
‡ Most leaves already shed.

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A New Crawler Tractor

(*continued from page* 59)

thick jungle or forest either for clearing scrub, breaking up hard surfaces, tearing out roots or hauling out timber in confined spaces, *i.e.* for thinning out a forest plantation. It could also be used for ordinary road grading or levelling work or for the preparation or reverse-slope contour terraces, such as are required for pineapples or paddy, when planted on steep hillsides, as in Hawaii, Indonesia or Ceylon.

Today, when so many coconut planters are being faced for the first time with the problem of uprooting and removing senile palms, this is the machine which would appear to meet their requirements. At the same time, it may be used with the standard implements of Ferguson and David Brown for cultivation, manure spreading, post-hole boring or winching operations or with the Bristol angle-dozer and scraper units.

The latest model, which has now been in production for over two years, is the result of over 20 years' experience by the manufacturers in building track-laying tractors, and Bristols are exported to over 40 markets throughout the world.

Grapefruit for British Breakfasts

Citrus growers in Jamaica are thinking of capturing Britain's out-of-season market with more grapefruit for the breakfast table. It is intended to develop those areas where fruit will mature either in early autumn or late spring, when, it is thought, a good market for both fresh and canned fruit exists in the U.K. The Agriculture Development Corporation are to plant 400 acres of grapefruit in a region where it is expected that by special cultivation the fruit may be produced in the late spring and summer instead of in the winter, the normal season for citrus fruit in Jamaica.

Technical News

Included in the February issue of *Dairy Engineering* are articles on ' Milk Cartoning in the Smaller Dairy ', and ' Planning the Medium-size Dairy ' by D. Kingston.

Chemical & Process Engineering for February contains an article on 'Sugar-cane Processing' by C. D. H. Vernon.

The February issue of *Food Manufacture* contains articles on ' The Keeping Qualities of Fruit and Vegetable Concentrates ' by K. Vas, ' Malt Vinegar Production ' by Dr. Friedrich Martens and a report on ' Milk Powder Manufacture'.

Automation Progress for February includes articles on ' Trends in Automatic Milling and Baking ' by D. G. Elias, and ' American Trends in Automation '.

WEED CONTROL

A RECORD OF STRIKING PROGRESS

SIR E. JOHN RUSSELL, F.R.S.

Sir E. John Russell, F.R.S., delivering the opening address at the Third British Weed Control Conference

We are privileged to be able to publish this long abstract from the Opening Address read before an international gathering of scientists, farmers and manufacturers assembled for the Third British Weed Control Conference. From Neolithic times until the present time Sir John reviews the progress made in Britain in the battle against weeds, with several asides to cover important work undertaken in North America. To say that progress has been rapid in the last decade is a distinct understatement, but we can be sure that the war against this scourge of the agriculturist will not end until an answer has been found for all the problems that yet remain.*

I PROPOSE to make a broad survey of the progress already achieved in weed control in Britain. The subject is an old one: the first tillers of our soil, the Neolithic peoples who landed here some 4,000 years ago, bringing their seeds with them, brought also accompanying weeds to which our native flora contributed. Primitive implements could do little against them. But they had their uses; after the harvest the weedy stubbles provided grazing for livestock, and, if we may judge from peasant countries today, many of the weeds, while still green and succulent, would be pulled up by the women to feed the small animals about the dwellings.

Effective control of weeds began only in the early 18th century when Jethro Tull conceived the idea of growing crops in rows and cultivating between them. He was not thinking primarily of weeds, but supposed that plants fed on finely divided soil. But he achieved much more than he knew; his book, ' The New Horse-Houghing Husbandry ' published in 1731, went through several editions; it is one of the most fruitful in the world range of agricultural literature for it ushered in the great revolution that began with rotations and ended with cleaner crops and a close linkage of arable and livestock husbandry.

Farmers learned the lesson: by growing only one or at most two corn crops, a winter and a spring, in succession, and using a proper rotation and hand weeding where necessary, the best of them were able to keep their arable land remarkably clean. In those golden years between 1855 and 1880, British farming was famous throughout the world and agriculturists came from far and near to see it and admire.

But those golden days ended; long years of depression set in from 1880 to 1900 and all that Lawes could advise farmers was that they should never spend a shilling more on the land than they could possibly help. Some valiantly struggled to keep down the worst weeds in their grass lands, but the war against weeds seemed lost.

The new era

By 1901, although it was not realised at the time, two new agencies had been discovered which were destined to change the situation drastically: the internal combustion engine which led to the tractor and rapid cultivation; and a chemical method of controlling weeds. They were both in embryo and agriculturists knew little about them.

The story of chemical treatment is one of the romances of science. It began about 1885 with the efforts of a vine grower in Bordeaux to protect his grapes against the depredations of the village boys; having a little chemistry he knew that the addition of lime water to copper sulphate produced a nasty looking greenish mess, and he hoped that if sprayed on the grapes it would protect them effectively. It did, and to his surprise it did more—it protected against the mildew which was then causing great losses; also it did not damage the vines. On one occasion when somebody had upset some of it on the ground where plants were growing an observant person noticed that some charlock among these plants was killed. The observation was followed up and in 1896 Bonnet announced that a weak solution of copper sulphate sprayed on to a weedy corn crop destroyed the charlock without serious damage to the corn. Two years later the method was demonstrated by Strawson near Chelmsford: it was promptly taken up

*Abstracted from the address given by Sir E. John Russell, F.R.S., to the Third British Weed Control Conference at Blackpool, England, on 6 November, 1956.

by the Agricultural Institutes of those days, and numerous chemicals were tested, especially in the U.S.A. Copper sulphate remained the best; sulphuric acid had good points but was difficult and dangerous in use.

In the early 1900s a new fertiliser was announced. Sir William Crookes had rather frightened the world in 1896 by declaring that world starvation would soon be upon us unless methods could be devised for making nitrogenous fertilisers from the air. This was done and among them was calcium cyanamide, the least effective of the group but the easiest to make as it required the least power. It proved a useful weedkiller, selective in that it stuck to broad-leaved plants and killed them but could not so firmly stick to the smooth upright stalks of the cereal. It had the advantage of yielding ammonia in the soil which rapidly nitrified and became a good fertiliser, but it was disagreeable to handle and the men did not like it.

Others came in when the first world war ended: considerable quantities of sodium chlorate and perchlorate were released and found some use as weedkillers; sodium arsenite also was available. The position in 1919 was that the world of inorganic or mineral substances had been pretty well explored for effective herbicides, only about half a dozen had emerged as really useful; copper sulphate was by far the best and most convenient; its disadvantage was the large amount of water required: 50 gal. of a 3% solution, which meant 4½ tons of water for a 20-acre field of barley—a considerable quantity in those days when all water had to be pumped and in a dry season wells might run dry. With this limited range of substances, little progress, either scientific or technical, could be made.

The advance of organic chemistry

The next great advance came in the middle 1920s when the chemical industry of Great Britain was completely reorganised. Before the first war the principle underlying our political thinking was that each country should make the things it could do best and then exchange surpluses with other countries. The disadvantages of the system became evident during the war; for example, our dyestuffs, pharmaceutical and other fine chemicals had all come from Germany and we had been making only the so-called heavy chemicals, the alkalis, the commoner acids and a few very simple salts. All this had to be changed, and thanks to the energy of Alfred Mond, Clavering Fison, Jessie Boots and several others, we developed a highly efficient chemical technology capable of producing the most complex compounds, organic and inorganic, in any desired state of purity.

The contribution of industry

This new manufacturing system required as an indispensable partner a highly organised and very efficient research service equipped with men and appliances at least as good as could be found in any University. Imperial Chemical Industries was established in 1926—in the following year it set up the agricultural experiment station at Jealott's Hill, at first chiefly for fertiliser investigations, but within a few years weed-control research commenced there. Being linked with Imperial Chemical Industries' extensive factory and research organisation, the staff have access to an indefinitely large number of substances, organic and inorganic, and enviable facilities for studying them. Since 1937 an associated company, Plant Protection Limited, has done much work at Fernhurst.

There have been other great developments. Pest Control Limited was founded under the guidance of Sir Guy Marshall and W. E. Ripper, primarily for the purpose of doing the actual controlling by contract. Later, reorganisation was undertaken by Messrs. Fisons. This work has had the valuable result of familiarising farmers with the use of the new agents and stimulating research into the best means of applying them. Fisons Pest Control Research Station at Chesterford Park was opened last month by Sir William Slater.

Boots Pure Drug Company have also entered the field: their experience in the manufacture of pharmaceuticals enables them to make a wide range of specialised control agents which are likely to be more and more needed. Another firm, well known for high quality chemicals, May and Baker Limited, is now making herbicides, and Shell Chemicals Limited not only make control agents but have set up an experiment station at Woodstock near Sittingbourne. Mention should also be made of Monsanto Chemicals Limited.

The advantage of organics

The supreme advantage of the organic compounds is that an extensive series can be made, all of the same general pattern but varying in the groups of which they are built up; and as their properties depend on their constitution it becomes possible to modify the properties in various directions, when the details of the dependence have been discovered. If a substance otherwise desirable has some undesirable quality, a search among the variants may always reveal one that is free from it or has the desirable quality to a higher degree. Two methods of investigation are adopted. Large numbers of chemicals can be tested on many weeds and screened, or the effects of selected substances on selected plants can be studied in great detail to find out their mode of action and any relationships that may subsist between chemical constitution and specific physiological effects.

Both methods are necessary. The screening method requires ready access to a vast number of substances and correspondingly wide range of appliances. This is beyond the capacity of a State or University research organisation and is best undertaken by large-scale manufacturers who have the necessary research organisation and all necessary equipment. It is a tedious method. Warren Shaw, in the very stimulating paper he presented to this Conference in 1954, described it as 'time-consuming, inefficient, frustrating, and costly'. But it works. It is used at Jealott's Hill by W. G. Templeman and his colleagues, who can obtain many of the organic compounds that human ingenuity can devise.

The compounds first picked out were poisons, mostly benzene-ring compounds. Benzene itself is not very toxic but it becomes so when certain other groups are added. The most popular are the hydroxy-, nitro-, and chloro-groups. DNOC, dinoseb, and pentachlorophenol have proved very useful, and properly used they are selective. DNOC, associated with Pest Control, can be used to kill cleavers in cereals which some of the

other herbicides cannot touch. This enlisting of organic chemistry enormously enlarged the range of possible herbicides. Nevertheless had it stopped at direct poisons its effects, however remarkable, would not have introduced any fundamental new principles into the subject.

A revolution: the hormone pattern

When growth-promoting substances were first discovered in plants, agricultural chemists naturally tested them to see if they would stimulate growth when applied to the plant. They did not. Indeed in water culture experiments at Rothamsted and elsewhere they often proved harmful. The extent of the injury varied with different species, however. Quite independently, and by totally different approaches, it was found both at Jealott's Hill and at Rothamsted that wheat suffered less than some dicotyledons, suggesting that these auxins could be used to destroy weeds in grain crops. As they were rapidly decomposed in the soil they had to be protected by the introduction of chlorine atoms into the molecule to make them more resistant to bacterial action. The work was done during the war but publication was forbidden by the Government: nothing was announced until 1945. It then appeared that the discovery had been made at Jealott's Hill in 1940 and at Rothamsted in 1942.* Rothamsted did not proceed with field trials and subsequent investigations were made at Jealott's Hill and by G. E. Blackman, first at the Imperial College and later with an Agricultural Research Council Unit at Oxford. Another unit for laboratory studies was set up later at Wye College under R. L. Wain.

The fact that substances of hormone type were so effective greatly extended the list of possible herbicides. Two came into wide use because of their ease of manufacture and of application on the farm: MCPA and 2,4-D. Their great advantages over the direct poisons appealed very much to farmers especially because they are non-poisoning, do not stain the workers' clothes, and are so highly effective that only small quantities per acre are needed, which can be applied in low-volume sprays requiring little water. They soon became very popular in Canada as they not only increased yields but enabled the prairie farmers to modify their cultivations so as to reduce the hazard of soil erosion. In Great Britain they proved so effective in grain crops that many dicotyledonous weeds came well under control and this has been an important factor in the dramatic rise in yield of cereals in this country in recent years.

Root crops are not so easily freed from weeds as are cereals. The difficulty is that the leaves of root crops are very sensitive to herbicides, and pre-emergence treatment has proved difficult so that it is not as yet widely practised; so much depends on the timing and on the weather. Many vegetables are as sensitive as the leaves of the root crops, but steady progress is being made in controlling weeds in them.

A large number of other substances prepared by the ingenuity of organic chemists have been tested by the industrious workers on herbicides but are not yet classified. Among them are the nitrogen compounds: amides, imides, substituted ureas, carbamates, and rings like triazole, containing several nitrogen atoms. Some of these are effective against grasses and other monocotyledons, being readily translocated in them. Some, including triazole derivatives, inhibit chlorophyll production in a number of species. The amine of maleic hydrazide, one of the most unlikely compounds ever to get outside a laboratory, acts adversely on grasses; and experiments at the St. Ives Station, Bingley, have shown that it could be used to stunt their growth on roadside verges, though it would not be admissible on a putting green.

How do herbicides act?

Much work is being done to discover how the various herbicides act. Systematic investigations have been going on at Oxford since 1946 by G. E. Blackman and a team of Agricultural Research Council workers. All aspects of the action of herbicides are studied: their retention, their absorption by leaf or root, their translocation within the plant and the place and mode of their action. The influence of light and other environmental factors is also studied. Their work has shown that the action of the hormone herbicides appears to be not so much a direct poisoning as an upsetting of the metabolism of the plant.

Various disturbing effects of this kind are known. Blackman and colleagues have found that the hormone having entered the plant cells reduces the entrance of the nutritive ions: nitrogen, phosphate and potassium. Some herbicides prevent the formation of chlorophyll. Since the metabolism of the plant is largely operated by enzymes it may be supposed that some herbicides somehow put them out of action.

Much work is also done to find relationships between the action of the herbicide and its chemical constitution and R. L. Wain and an Agricultural Research Council Unit at Wye are studying the fate of herbicides that enter the plant. Starting with auxins like 2,4-dichlorophenoxyacetic acid, homologues differing in the numbers of methylene groups in the acetic acid chain are found to be active if the numbers are odd and inactive if they are even. The explanation is that the compound is broken down within the plant by oxidation of the β-carbon atom in the chain—the second from the carboxylic group. If the number of methylenes is odd a toxic substituted acetic acid is finally produced; if the number is even, the product is different and inactive. The oxidation is brought about by an enzyme which, however, occurs only in certain plants. These, therefore, are killed, but those not containing the enzyme escape. Clover and some vegetables are in this latter group whereas some of their associated weeds are in the susceptible group and are, therefore killed. The simplest of the odd-numbered homologues are the butyric compounds and these are coming widely into use.

Wain has made an ingenious deduction likely to have far-reaching consequences. A toxic chemical X can be combined with a smothering group *Y* to produce a non-toxic combination X*Y*. Plants and other organisms containing an enzyme that can break the combination and release X will be killed; those that do not will escape injury.

Among a wide range of compounds, selectiveness thus turns on whether the plant does or does not contain the

*The Jealott's Hill work is recorded by W. A. Sexton, R. E. Slade and W. G. Templeman and that of Rothamsted by R. S. Nutman, H. G. Thornton and J. H. Quastel in *Nature*, 28 April, 1945. The full account appears in the *Annals of Applied Biology*, 1955, **42**, 162, which also records the American contributions.

particular enzyme that will liberate the active group. The interaction of enzyme and herbicide is modified by the substitution groups; some of these can even inhibit β oxidation. The enzyme and the herbicide are related structurally as a key to a lock, and this simile emphasises the fact that the interaction is a three-dimensional affair, although we are brought up to think of chemical reactions in terms of two-dimensional blackboard drawings.

This field of Capelle wheat, which has a history of cleavers, has been sprayed with 'Iso-Cornox', one of the new herbicides announced at the Third British Weed Control Conference

Agronomic experiences and problems

Herbicide investigators would do well to gather up as much of the farmers' knowledge as they can. In the parallel studies of fertilisers we found farmers' observations most helpful; frequently they had seen something which we had missed and they were able to provide us with those most useful aids to all scientific work—exceptions to what at first look like well-founded rules.

Already farmers have raised a certain number of problems.

Another problem of increasing importance directly affects the makers of herbicides: the damage done by drifting of chemical sprays to a neighbour's crops. A few weeks ago aggregate damage to the extent of more than £10,000 had been reported in Britain during the 1956 season. Essex seems to suffer particularly; articles on the subject regularly appear in the *Essex Farmers' Journal* and 27 cases have been reported in 1956. Not all of this is herbicidal spray, but MCPA and 2,4-D get much of the blame. We learn from the Handbook issued annually by the British Weed Control Council that the drift is most pronounced with the lower alkyl esters, and that there is very little with the ethyl butyl ester or the amine derivatives.

A further problem discussed in the Annual Report of the National Institute of Agricultural Botany is that herbicides may cause malformations in plants which are a serious detriment where crops are grown for seed. The Handbook states that this does not usually happen if the spraying is done sufficiently late, but varieties differ in their behaviour, and the matter is so important that the co-operation of the Institute might well be sought for an experimental enquiry to arrive at some general rules for the guidance of growers.

Extent of herbicide use

At the present time the use of herbicides is very patchy and includes only a few out of the vast number proved to be valuable. B.M. Church's survey showed that in 1954 in the arable regions of England between a quarter and a half of the cereal acreage was treated with herbicides but in the grass regions the proportion was much lower. Where less than one-third of the farm land was in tillage only about 10% of the cereal area was treated. About 80% of the treated area had received MCPA; most of the rest had had 2,4-D or DNC formulations. This great preponderance of MCPA over 2,4-D does not mean that it is intrinsically superior to that extent. Indeed E.K. Woodford told the Essex Farmers' Conference last February that 2,4-D might be cheaper and better for their winter cereals, though MCPA would still be preferable for the spring-sown cereals, oats and barley. In any case I understand that in the U.S.A. 2,4-D is far more popular than MCPA.

The farmer's problem is not necessarily the same as the investigators. His purpose is not so much to destroy every weed but rather to reduce the competition between the weed and the crop to negligible proportions. Dr. Templeman discussed this problem of competition at an earlier conference and raised the question whether killing the weeds was essential or whether it would not suffice to weaken them so as to shift the balance in favour of the crop, which could then exterminate them. A weaker application of the herbicides might suffice, which might even thus become more selective.

In further investigations on pre-emergence treatments it will be interesting to see if the herbicide has any partial sterilising effect on the soil, resulting in the increase of bacterial numbers and the production of more ammonia in the soil, whereby plant growth is improved. Experiments with compounds closely related to some modern herbicides were made at Rothamsted some 30 years ago and observations on the growth of the plant were recorded which could not then be explained.

Rotation of herbicides

The great merit of the hormone herbicides, their selectivity, is also the cause of a serious difficulty. No single substance deals with all weeds, and to eliminate some may simply give those left untouched a better oppor-

tunity to develop and build up a formidable population. Instances of this ecological shift on farms in the U.S.A. were given by Warren Shaw in the paper I have already quoted. The wide use of 2,4-D greatly reduced the broad-leaved annual weeds but left a clear field for wild grasses and broad-leaved perennial weeds, which consequently increased. There is undoubtedly real danger in relying too much on one herbicide. There is even the possibility as Prof. Blackman hinted—though we hope only a very remote one—that persistence in one type of herbicide might result in the emergence of resistant strains in the weed population. Farmers have already been advised to practise a rotation of herbicides, and both here and in the U.S.A. it is recognised that a larger selection of specialised herbicides should be used to deal more directly with specific weeds.

Meanwhile the most satisfactory procedure is to work out a proper partnership between the use of herbicides and cultivation. Dr. E. Aberg, spoke of herbicides at an earlier Conference as the 'complements' of the mechanical operations; and Prof. Sanders emphasised the fact that no chemical treatment would make up for bad cultivation. Fortunately, modern cultivating implements are now so speedy and so effective that they require much less man-power than in the old days, and cultivation can be completed within a short spell of suitable weather instead of dragging on for weeks, as used to happen. Here, however, timing is all-important to ensure tackling the weeds at their susceptible stage, and as Buckman pointed out more than 100 years ago and many agricultural botanists have emphasised since, a knowledge of the biology of weeds is essential.

Time does not permit any account of the improvement of spraying techniques studied at Oxford and elsewhere; but just as the engineer has completely revolutionised cultivation in recent times so he has improved spraying operations out of all recognition. A degree of control unimaginable a few years ago has been attained. Sprays ranging from fine mists to droplets of a desired size can be produced, allowing effective control of the volume of spray needed for a given area, an important economic consideration greatly facilitating the extension of chemical control.

It is quite certain that herbicides will take their place among agricultural and horticultural appliances just as fertilisers have done. There were not wanting people who, in the early days of fertilisers, saw them completely ousting the traditional farmyard manure. But they did not. They fitted in with farmyard manure, and raised plant nutrition to such a level that yields are now far higher than ever they were. So it may happen that weed control agents will be combined with modern rapid tillage methods to give us cleaner crops than we have had before, so further increasing crop yields.

To Authors and Readers

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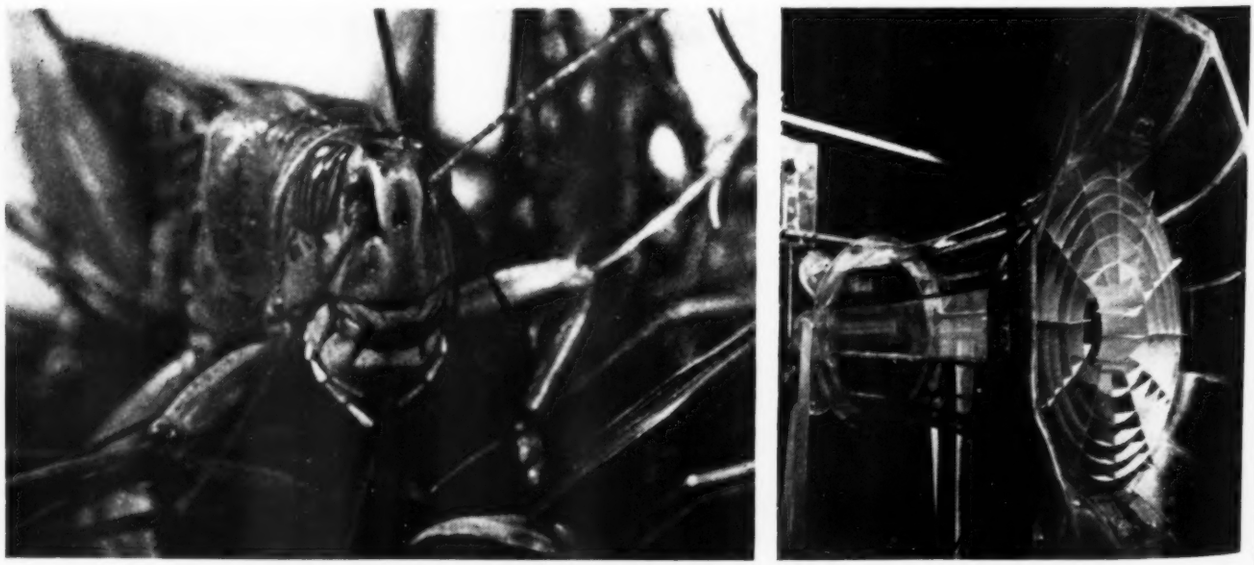


The Ruthless one

Under the above title the Shell Petroleum Co. Ltd. have added to the series of Shell films on insect pests. The film begins by showing the size and nature of the desert locust (Locusta migratoria) *problem as it is actually experienced in the countries afflicted. From there it proceeds to study the locust itself, revealing by specially shot close-up sequences mating, egg laying and hatching, the growth of the immature hoppers and their coalescence into marching bands, the emergence of the winged adults, and the formation of the destructive swarms, which may each consume some 2,000 tons of food per day. The latter part of the film shows how information obtained from many countries is mapped and analysed by the Anti-Locust Research Centre in London, and how probable movements can be forecast so that the countries affected can be warned to prepare counter-measures in time. The stills from the film* (above) *show a close-up of the locust and a wind tunnel in which spraying techniques are tested under conditions simulating those encountered in the air.*

Recent Advances in Weed Control

Mammoth Programme at Blackpool Conference

IN opening the Third Weed Control Conference, organised by the British Weed Control Council, Sir James Scott Watson said it was difficult for the farmer to keep pace with recent rapid advances in knowledge and his mind was becoming increasingly confused by the overwhelming volume of new work. He pointed out that it had taken three centuries to raise yields from four to six bushels per acre, 100 years from six to eight bushels, and in the last 10 years they have been raised from eight to ten bushels. The use of fertilisers, insecticides and weedkillers, and the farmer himself, have all played a part in this progressively rapid advance in productivity.

The purpose of the Conference was to bring together all those concerned —scientists, manufacturers, merchants, advisory officers and farmers, from home and abroad, to discuss the latest developments in and problems of the fight against weeds. He warmly welcomed Sir John Russell who then gave the opening address, which is printed separately in this issue.

The Proceedings of the Conference are to be published in full by the Council; we are publishing a number of short abstracts of selected papers.

Principles of Selective Toxicity *by Prof. G. E. Blackman (Department of Agriculture, Oxford University).*

The selectivity of a herbicide applied in the form of a spray depends on five factors: (1) retention, (2) penetration, (3) translocation, (4) accumulation, and (5) effects within the plant cell. The fundamental work now in progress at Oxford on each of these facets of selectivity was described.

Chemical Weed Control and Farming Methods *by R. E. Slade (Farmer, Bishops Stortford).*

Developments in the use of fertilisers, pest control chemicals and selective weedkillers have made it unnecessary for the farmer to stick closely to the customary systems of crop rotations. In place of these fixed rotations, the farmer now has the knowledge to grow more of the crops which are required either to suit individual soils or to take advantage of market demand.

A view of the Conference in session. Many of the oversea delegates visited England especially to attend the Conference

Weedkiller Usage in England and Wales *by D. A. Boyd (Rothamsted Experimental Station).*

Taking the past three seasons together, in the mainly arable districts of the eastern and northern counties, between one-third and two-thirds of the cereal acreage has been sprayed with some form of weedkiller. Whereas the use of herbicides is most widespread in arable districts, recent surveys in Gloucestershire, Somerset and Wiltshire show that, even in some typical dairying districts, the practice of spraying cereals is becoming common. In Wales and much of the south-west, the use of weedkillers is still exceptional, none of the areas surveyed having more than one-tenth of their cereal crops sprayed.

Factors Influencing the Farmer's Acceptance of New Techniques *by G. P. Hirsch (Agricultural Research Institute, University of Oxford).*

The time-lag between the discovery of a new technique and its translation into everyday use by farmers is roughly ten years. The various factors which bring about the acceptance of a new technique are discussed.

The survey carried out in 1954 shows a variation in the number of ground sprayers owned by farmers from 0.1 per 1,000 acres of field crops in Merioneth to 3.5 in Kent. It is the counties in East Anglia, the south-east counties and those lying in a broad band through the Midlands which have the highest numbers of these machines. These have at the same time the highest percentage of large holdings, a higher density of agricultural employment and a higher proportion of their land under crops.

Comment by A. J. Cannon (Farmer and Spraying Contractor, Banbury).— The judicious use of chemical weedkillers can lower the man-hours per unit of production and increase the yields per acre and so reduce the overall costs of production; but the average farmer with only 50 acres under arable crops cannot hope to achieve this effect without personal advice, practical demonstration, and organisation into co-operative units

for mutual assistance. The spraying contractor with a farming background can provide this service, give the necessary credit, and he is always available in emergency.

The Field Problem of Wild Oats *by C. V. Dadd* (*National Agricultural Advisory Service*).

Wild oats is now a more serious problem than before the war. The principal causes—the introduction of the combine-harvester, the use of impure seed, deep ploughing and weather variations — are discussed. Complete eradication does not appear to be a practicable proposition and even the most promising methods of control are at present only supplementary to ordinary husbandry and crop-rotation methods.

Chemical Methods of Wild-oat Control *by R. K. Pfeiffer* (*Fisons Pest Control Ltd.*).

It has been estimated that two-thirds of the 100 million acres of cereals grown in Canada are infested with wild oats and the annual damage is approximately 100 million dollars.

Treatment with TCA has given the most promising results as a wild-oat cleaning treatment for soils under sugar-beet and kale, but hoeing and hand weeding are necessary to remove any residual wild oats and prevent it from seeding. Chemical and cultural control combined will reduce the menace of wild oats to a minimum.

Experiments to Control Wild Oats *by R. D. Blackett* (*Monsanto Chemicals Ltd.*).

In the eastern counties of England it has been estimated that 30% of the cereal acreage was infested with wild oats. To date cultural methods have been the only means of control.

The herbicides CDAA (chloro-NN-diallylacetamide) and CDEC (chloroallyl diethyldithiocarbamate) have now been proved to be effective in controlling wild oats in barley as a pre-sowing or post-crop emergence treatment. In peas and sugar-beet, CDEC was the more effective herbicide. A high soil moisture or a heavy post-spraying rainfall increased the effectiveness of CDAA.

Weed Control Research and Development in Sweden *by E. Aberg* (*Royal Agricultural College, Sweden*).

Various aspects of the extensive programme of weed-control research now being carried out in Sweden are described. The conclusion from the experiments on wild oats, using various chemicals, is that these are not as effective as the mechanical treatments in a good crop rotation. Experiments to determine the value of MCPB for weed control in clovers, peas and barley have shown that some varieties of these crops are more susceptible to this chemical than others. He stresses the need for more research on the biology and ecology of cultivated plants and weeds so as to improve the competitive power of the main crop and prevent the increasing domination of resistant species of weeds after other weaker species have been controlled by chemicals, and also for more knowledge of the effects of climatic conditions on different types of herbicide.

Weed Control and Weed Biology in Canada *by C. Frankton* (*Department of Agriculture, Ottawa*).

In Canada, the task of the various research agencies is to determine how herbicide chemicals act under their conditions. No brand of herbicide can be manufactured, imported or offered for sale without registration. Labels are inspected to see if the claims and directions are in accord with information available and are sufficiently complete. With new herbicides, supporting evidence is required in the form of abundant documentation and experimental results. Registration may be refused if the brand name is misleading, or is essentially similar to another brand, or the product is unsuited for the purpose for which it is offered, or is injurious to other economic plants, domestic animals or public health.

The value of MCPA has been only tardily recognised in North America and in 1955 only about 2% or 283,000 acres was treated with it, but there is every indication of greater usage in 1956. Products containing 2,4-D were first registered in late 1945 and by 1950 13 million acres were being treated. No other innovation in agriculture in Canada has met with such ready and rapid acceptance.

The general problem of weed control on pastures and range lands has hardly been touched, as chemical control has not found acceptance except by a minority of cattle farmers.

The Application of Herbicides in Russia (*through an interpreter*).

Because of the wide variety of crops and zones, the weed flora of Russia includes a large number of species and in consequence weed control is one of their chief activities.

As a result of studies carried out since the last war, 2,4-D and MCPA are now being generally applied to cereal crops. A method of combining the application of hormone herbicides with fertiliser and insecticide applications is being studied.

The Evolution of Weeds Resistant to Herbicides *by J. L. Harper* (*Department of Agriculture, Oxford University*).

This paper directs attention to the danger of the intensive and extensive use of herbicides and the existing evidence is reviewed.

The following techniques and methods are suggested for delaying the evolution of resistant strains of weeds.

1. Resistance cannot evolve when the treatment produces 100% kill.

2. Unrelated herbicides, used in combination, should reduce the danger.

3. Herbicides with mutagenic activity should be avoided.

4. The possibility of synergistic interaction between herbicides (mutual co-operation) requires further study.

5. The population of a specific weed must either be eliminated entirely, or the greatest possible variety and number of that weed should remain untreated in adjoining waste land and hedgerows.

A New Method of Selective Weed Control for Related Plants *by W. E. Ripper* (*Fisons Pest Control Ltd.*).

No-one has yet discovered a weed-killer which can distinguish between plants of the same type, e.g. broad-leaved weeds with beet or black grass in cereals. An interesting new technique and special equipment for selective control is described. The seed is protected from the pre-emergence weedkiller, which is to be sprayed over the soil, by a sandwich of absorbent activated carbon which is introduced mechanically between the line of seed and the top surface of the soil. This allows the seed to germinate and grow in the uncontaminated soil while the germinating

weeds in the sprayed soil above are being killed. The young beet plants break through the sandwich later when the herbicide, by evaporation, decomposition, or dilution, is no longer toxic.

Control of Black Grass in Grass Seed Crops *by R. S. L. Jeater (Plant Protection Ltd.).*

In crops of perennial grasses grown for seed, satisfactory control of black grass (*Alopecuras myosuroides*) was obtained by applying CIPC (chloro-*iso*propylphenyl carbamate) and IPC (N-phenyl *iso*propyl carbamate) at 2 and 4 lb. per acre respectively in October.

Control of Couch Grass by Chemical Means *by T. C. Breese and P. F. Brocq (Plant Protection Ltd.).*

The control of couch grass (*Agropyron repens*) in unploughed land or as a regrowth after ploughing by dalopon applied in the autumn was in excess of 90%. Application in the spring gave a control in excess of 95%. The treatment produced a marked inhibition of rhizone bud development, but no actual death of couch rhizomes was observed.

Effect of Phenoxybutyrics on Cereals (1) *by T. C. Breese (Plant Protection Ltd.),* (2) *by F. R. Stovell (Shell Chemical Co. Ltd.),* (3) *by J. G. Elliott (A.R.C. Unit of Experimental Agronomy),* (4) *by C. Baker and R. Pfeiffer (Fisons Pest Control Ltd.).*

(1) MCPB proved inferior to MCPA for the control of annual weeds. Satisfactory control of charlock (*Sinapis arvenis*) and fat hen (*Chenopodium album*) was obtained with MCPB applied in the seedling stage.

(2) Early applications of 24 oz. active acid content of MCPB or 5 oz. of MCPA give a comparable and satisfactory control of annual weeds.

(3) Applications of 4 lb. per acre of MCPB or 2,4-DB applied at the three- and four-leaf stage did not cause significant yield reductions in comparatively clean barley. A similar result was obtained on clean spring oats at the four-leaf stage, with 3 lb. per acre of MCPB or 2,4-DB. In general, MCPB was less toxic than 2,4-DB and MCPA, which showed about equal toxicity.

(4) At dosage ratios giving a similar degree of weed control, 2,4-DB was the most toxic compound to barley and spring wheat and when sprayed early produced the highest number of deformed ears, followed by MCPA, 2,4-DB and MCPB.

Effect of MCPB on the Yield and Maturity of Peas *by K. Carpenter (May and Baker Ltd.).*

Applications of MCPB to 12 varieties of peas have demonstrated that eight varieties show high tolerance at treatment rates as high as 3 lb. per acre or even at 6 lb. per acre in some cases. The variety Gregory's Surprise was susceptible at all the dose rates tried.

Variable Dosage Spraying (1) *by G. S. Hartley, R. Pfeiffer and R. T. Brunskill (Fisons Pest Control Ltd.),* (2) *by J. D. Fryer (A.R.C. Unit of Experimental Agronomy, Oxford).*

Up till recently, the established method of assessment of herbicides in the field has been to spray a large number of small plots in separate operations. This method of measuring comparative toxicity is laborious.

An alternative and much simpler method of measuring the effect on the crop and on the associated weeds is offered by the logarithmic sprayer, which can produce a progressive spectrum of treatments in one continuous operation and the results can both be seen and measured.

The machine described in the first paper is designed to spray large plots of about 30 yd. in length; for the research worker a small-scale version of the large tractor-mounted logarithmic sprayer has been designed for plots 2½ yd. wide and about 9 yd. in length. This is described in the second paper.

Spray Nozzle Performance (1) *by A. Westerman (George Bray and Co. Ltd.),* (2) *by K. Holly (A.R.C. Unit of Experimental Agronomy, Oxford),* (3) *by R. T. Brunskill (Fisons Pest Control Ltd.).*

It is important that the correct dosage of herbicide be distributed as evenly as possible and be retained uniformly by the target plants. The scientist developing a herbicide needs to have a knowledge of spray nozzles, their performance and their limitations.

The different types of spray nozzles now available are described in the first paper.

The second paper is an account of investigations of nozzle performance. It has been found (1) that new nozzles of identical type and size are likely to vary very considerably in the distribution pattern they produce; (2) that changes in spray distribution caused by small fluctuations in pressure are by no means negligible; and (3) that spray distribution can vary according to the nature of the solution being sprayed.

In the third paper an account is given of a series of experiments carried out to assess the effects of various factors on the retention of spray droplets on pea leaf surfaces. The results show that retention increases with

Three oversea delegates to attend the Conference (from left to right) *were Mr. M. J. Zwijns (Holland), Dr. F. H. Feekes (Holland) and Dr. Linke (Germany)*

decreasing surface tension and decreasing droplet size; retention decreases, owing to droplet bounce, as the angle of incidence increases. The percentage retention of droplets of all sizes also decreases as the droplet velocity decreases.

Chemistry and Herbicidal Properties of Triazine Derivatives *by H. Gysin and E. Knusli (Geigy Company, Basle).*

This paper describes an entirely new group of herbicides—the triazones. The most promising among them, G 25804 (chloro-bis-diethylaminotriazine) is claimed to be tolerant to maize, sugar-cane, cotton, sorghum, grapes and a number of horticultural crops, while dealing effectively with most weeds.

A New Development in Selective Weed Control *by G. B. Lush and E. L. Leafe (Boots Pure Drug Co. Ltd.).*

Galium aparine (cleavers) is a major cereal weed problem in the United Kingdom and to a varying extent in a number of overseas countries. This plant has become increasingly troublesome in cereal crops, partly owing to the introduction of the combine-harvester and partly through the destruction of other weeds by selective hormone weedkillers, causing dense stands of this weed to flourish alone.

A new product to be known as Iso-Cornox or CMPP (4-chloro-2-methyl phenoxy propionic acid) is shown to give in cereal crops a control of cleavers of the same order as DNC.

The effect of this new herbicide on the major crop has been studied; for wheat, barley and oats the margin of safety with this compound is much greater than with MCPA.

Farm Trials with 2,4-DES Alone and in Combination with Other Compounds for Weed Control in Horticultural Crops *by P. Bracey (Mirvale Chemical Co.).*

Sodium 2:4-dichlorophenoxyethylsulphate (2,4-DES) applied as a spray is converted into the active 2,4-D by the action of bacteria when soil conditions are favourable, and this obviates the hazard of spray drift to neighbouring crops which is present when the active hormone 2,4-D is applied directly. In certain circumstances the addition of other compounds to 2,4-DES appeared to be necessary to achieve immediate killing powers over germinating weeds, established seedlings and the older rooted weeds.

The new compound would appear to be of great value to market gardeners and nurserymen because it rules out the danger of spray drift.

It is quite certain that herbicides will take their place among agricultural and horticultural appliances just as fertilisers have done. There were not wanting people who, in the early days of fertilisers, saw them completely ousting the traditional farmyard manure. But they did not. They fitted in with farmyard manure, and raised plant nutrition to such a level that yields are now far higher than ever they were. So it may happen that weed control agents will be combined with modern rapid tillage methods to give us cleaner crops than we have had before, so further increasing crop yields.

Factors which Affect Performance of Chemical Compounds Used in Weed Control *by L. E. Coward (Du Pont de Nemours and Company Inc.).*

Soil sterilisation is successful when the herbicide is distributed in the soil profile where the roots are active and when it remains in phytotoxic quantities for a sufficient time to allow absorption of a lethal dose. The residual period determines whether the compound is a temporary or relatively permanent soil sterilant.

The amount of herbicide that is absorbed by the roots of weeds depends to a large extent on the amount of herbicide in solution in the soil water at the active root zone. Only that portion of material which is in solution is moved downward by the action of rain water, and at each level the material in solution is in equilibrium with that absorbed on the soil particles.

The mechanism of the action of a number of widely used soil sterilants is described.

Royal Agricultural Society of England

The British Royal Agricultural Show is to be held this year at Norwich in Norfolk from 2 to 5 July. Visitors from overseas are advised to make their arrangements for accommodation as soon as possible.

The Council has awarded the Society's Gold Medal this year to Sir Ian Clunies-Ross, C.M.G., Chairman of the Commonwealth Scientific and Industrial Research Organisation, for his outstanding services to agriculture in Australia.

World Coconut Conference

Information has been received that the World Coconut Conference, which was to have been held in Ceylon in February 1957, has been postponed owing to the political situation.

Rabbit Clearance Campaign

The British Ministry of Agriculture is urging a renewed campaign against the reappearance of the wild rabbit in Britain. There are more rabbits about than in 1955 and, although the increase is not as great as was feared—it seems to be most marked in the Midlands and South-East—survivors from myxomatosis could quickly form the nucleus of another heavy rabbit population if determined action is not taken. There are disturbing developments which indicate that myxomatosis will tend to play a diminishing part in reducing the rabbit population. In Britain the disease is spread almost entirely by the rabbit flea and, therefore, spreads rapidly only where there is a heavy rabbit population. The proportion of samples of rabbits' blood from different parts of the country that contain antibodies to myxomatosis continues to increase.

Although there are still some countrymen who are not in favour of exterminating the rabbit, 93% of the country is at present included in rabbit clearance areas, where occupiers are required by law to destroy rabbits on their land, and it is expected that the remaining areas will soon be brought in. Those who depend on farming and forestry for their livelihood have been energetic in their efforts to rid their land of rabbits and have been assisted by the Government in several ways. There is a subsidy on gassing powder, which is the easiest and most effective and humane way of destroying them; 50% grants are available towards the cost of clearing scrubland, bulldozing and fencing.

More About Smithfield

DETAILS of some of the agricultural machinery, implements and chemicals exhibited at the 1956 Smithfield Show were reported in the January issue of WORLD CROPS. In addition:

E. H. Bentall & Co. Ltd. introduced several new products, including a buckrake, a disk harrow and a potato spinner and a concrete mixer, both on wheels. The disk harrow has been designed for towing behind a tractor at high speeds.

Bowden (Engineers) Ltd. have a new hose coupling made of nylon, which was shown for the first time. It has applications in agriculture, and in industry; in fire-fighting, in irrigation, in chemical factories and in domestic water supplies. Bowden's hose assemblies are used on combine-harvesters, loaders, ditchers, tipping trailers and other types of hydraulically actuated agricultural machinery.

British Ropes Ltd. exhibited the 'Red Star' baler and binder twine, which is noted for its smooth run-out and reliability. The twine is available in four grades and can be used with any type of machine.

David Brown Industries Ltd. In addition to the new '900' tractor, the exhibits included a new version of their 50TD agricultural tractor with greatly increased strength in all vital parts. Other tractors shown included the 25D with three-furrow 'B'-type plough, the large 50D tractor fitted with a Boughton winch, and the small 2D tractor fitted with the 'Bean' multi-bar, which carries a wide variety of quickly interchangeable cultivating tools.

Robert Ingham Clark & Co. On this stand some of the many applications of paint in the agricultural machinery industry were demonstrated pictorially. A display in the form of a farm workshop illustrated the value and ease of paint maintenance.

Clifford Cultivators Ltd. showed five new machines on their stand. The new Mark II Clifford, a more powerful and larger version of the Mark I, has a 250-c.c. Villiers two-stroke engine and two speeds, 1 m.p.h. and 2¼ m.p.h. This tiller cultivates a 16-in. strip and can work down to 8 in. Two new versions of the Mark I model were also shown—one with an extra narrow tiller, 6 in. in width, for working rows as narrow as 8 in.; the other is a triple tiller unit, each unit measuring 6 in. across. The three tillers are mounted on an adjustable telescopic mounting, so that different row spacings can be worked. Also on show was the Clifford super scythe with cutter bars in widths of 24 in., 30 in. and 36 in. Their Continental motorised plough has a Jap four-stroke engine giving a forward speed of 1.5 m.p.h.

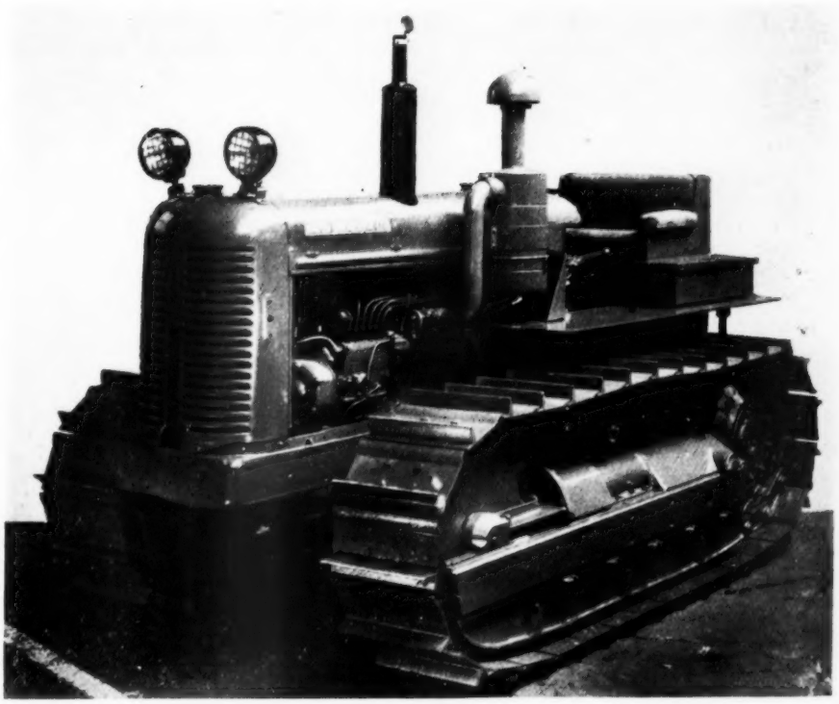
Edward Curran Engineering Ltd. exhibited a new implement, the 'Johnstone' buckrake, designed by a South Wales farmer. It consists of 10 curved tines fitted into a very sturdy frame and this will fit the hydraulic lift of all types of tractors. It is claimed that it can pick up and carry at least 50% more load than the conventional type of buckrake with straight tines. The load is carried nearer the tractor, giving greater stability and tractor efficiency, and the high lift gives easy access to the silage pit.

Dunlop Rubber Co. were exhibiting a wide range of their tyres. The tractor 'Universal' tyre and the 'Fieldmaster' were on exhibition for the first time. Also on show was the TF6 pattern front tractor tyre, embodying a permanent centre rib for smooth positive steering, heavily buttressed sidewalls to withstand the toughest conditions, and broken-out ribs to make clamping of furrows easy and give extra grip in turning. There was also a range of tyres for combines, balers, threshers, elevators, reapers and binders.

Electrical Development Association. The principal exhibits on this stand concerned the application of electricity to agriculture and in particular to the drying of grain and grass, which was of particular interest after the wet summer of last year.

Farrow & Sons Ltd. This company has now turned its attention to sprinkler irrigation and the equipment shown on their stand included the low-angle sprinkler for orchard irrigation and the standard-angle sprinkler for a wide range of agricultural and horticultural crops. Both machines incorporate the efficient Farrow 'Hy-speed' coupling.

General Electric Co. Ltd. Great emphasis was laid on the important part electric grain driers played in the



This new version of the David Brown 50TD six-cylinder crawler tractor embodies many important design changes, particularly in the final drive and track assemblies

13kW electric drier. In rainy areas and with damp conditions, grain-drying is essential to prevent the sprouting of wheat

gathering of last year's harvest. Equipment on display included a 13-kW. platform drier and a large vertical silo drier, each with an appropriate control panel. Other new equipment on the stand included pig and poultry warmers, incorporating 250-W. infra-red industrial lamps.

Glenaldie Woodworking and Engineering Co. Ltd. The Glenaldie-Pritchett hoist, which was demonstrated, is of simple tubular construction and this is connected to the three-point linkage and controlled through the hydraulic mechanism of the tractor. The lifting arm swings up or down and can be moved in a half-circle, thus enabling the tractor and trailer to draw alongside the article to be loaded.

Harrison, McGregor and Guest Ltd. exhibited a new version of the 'Albion' manure spreader, an exceptionally robust high-capacity machine. It has a capacity of 45 cu. ft., with 5-ft. 4½-in. wheel track and 6-ft. overall width. Its delivery rate can be varied from 4 to 20 loads per acre.

International Harvester Co. The equipment on display on this stand included diesel versions of all four types of their tractors and the differential lock was demonstrated in a cut-away display model. Another exclusive feature was the reversible linkage for both category one and category two implements. All their wheel tractors now have disk brakes. The large-capacity B-55T pick-up baler and the less expensive B-45 pick-up baler were also shown, together with the B-64 harvester thresher with the overrunning clutch, the on-the-run unloader and hydraulic control of the feeder platform.

Massey-Harris-Ferguson Ltd. On their stand the new Ferguson 35 De Luxe tractor was displayed on a revolving turntable. This new tractor incorporates many new features, resulting from 13 years of intense research. The Ferguson hydraulic system has been revolutionised. In addition to raising and lowering an implement and automatically keeping a plough or cultivator at a selected depth on uneven ground, the new hydraulic system gives the tractor driver perfect control of front-, mid- or rear-mounted implements. A new dual clutch gives a 'live' engine-driven p.t.-o. for power-driven implements, such as mowers or balers. A six-speed gear box provides a wide selection of gears for every job on the farm, enabling full use to be made of the 37 b.h.p. An alternative ground speed p.t.-o. in ratio to the tractor's forward speed provides power for such tasks as planting, hay-making or fertilising, irrespective of the gear selected.

Among the many other important new features included are more precise

The Glenaldie-Pritchett bag hoist can lift vertically and can be swung horizontally

and easier steering, two steering brake pedals on the right-hand side of the transmission housing, a new safety starter, safety fuel tank and instrument panel with a combined tachometer, speedometer and hour meter, foamed cushion seat and padded back rest.

Also on show were combine-harvesters, the 701 baler, the 728 super-seeder and the 712 farmyard manure spreader.

Ch. J. Neuman Ltd., manufacturers of 'Nubrex' greasing, exhibited an extreme high-pressure greasing booster, a bucket pump which can supply grease at a pressure of 5,000 lb. per sq. in., and the new 'Tite-Seal' nipple packs for tractors.

Scottish Mechanical Light Industries Ltd. exhibited a complete range of their products, including hammer mills, bagging equipment, grain

The 'Johnstone' buckrake, designed by a South Wales farmer

Massey-Harris 712 farmyard manure spreader. Exclusive feature is the ' lawn-mower '-type cylinder which ensures a wide, even spread and lightens draught. Capacity: 75 bushels. Feed rates: 4, 8, 12 or 16 loads per acre.

blowers, grain driers, grain transporters and silos. The Scotmec-Oxley instantaneous moisture meter for measuring the moisture content of any grain, whether in bulk or in sealed sacks, without sampling was also on show. Its insulated contact head has nine spear-like points or probes, which are thrust into the sack material without opening it. A handle is turned to generate the required 500 V. and the moisture percentage is obtained by a direct reading. The standard instrument is calibrated for wheat, oats, barley, rye and maize, and there is a special dial for paddy and milled rice.

J. E. Shay Ltd. The 15-in. ' Roto-scythe ' power lawn-mower is the latest addition to the products of this company. It embodies a number of unique features—instant height adjustment, vacuum grass collection, a cut-over rear roller and an improved high-powered engine. There was also a new model of the ' Rotogardener ', a sturdy machine for the inter-row cultivation of horticultural crops.

Rotary Hoes Ltd. exhibited for the first time the Howard ' Super-Trencher ', a more powerful and deep-digging version of the Howard trench digger. The salient features of this new machine are that it is powered by a new Fordson Major tractor equipped with a Perkins L4 diesel engine, it is capable of digging a trench up to 10 in. wide down to a maximum depth of 48 in., and it has a spinner-assisted mouldboard to clear the spoil thrown up by the rotor.

Other products on show were the 80-in. ' H '-type trailing rotavator, the 70-in. ' E '-type trailing rotavator, the Howard rotavator for the present and previous Ferguson tractors, and their latest Howard rotavator, the ' E ' mounted model, which fits all tractors with standard three-point linkage, and, in addition, the four hand-controlled Howard rotavators.

Skyhi Ltd. exhibited a range of hydraulic loaders and servicing equipment.

Their 'Quality' loader, was mounted on both the Fordson and Nuffield tractor units, together with a range of implements, including shovels with capacities of 10 and 12 cu. ft., manure fork, beet fork, jib, scraper blade, green-crop loader fork and hay sweep.

Also on view was the Skyhi ' Ardua ' heavy-duty loader, mounted on the Fordson diesel tractor unit. This loader will handle loads up to 35 cwt. Implements available are shovels with capacities of 1 and 1½ cu. yd. and a scoop which has a capacity of 1 cu. yd.

Wellworthy Ltd. The exhibits on this stand included the Wellworthy-Ricardo supercharger, the ' Duaflex ' oil control ring, pistons, cylinder liners, piston rings and the ' Wellseal ' jointing compound.

Shay ' Rotogardener ', Mark II

The latest Howard rotavator

High- and Low-Volume Spraying

A SYMPOSIUM on 'High- and Low-Volume Spraying Techniques on Fruit and Ground Crops', followed by discussions on the biological, chemical and engineering problems involved in the application of concentrate sprays, was organised recently by the Pesticides Group of the Society of Chemical Industry at the request of the British Ministry of Agriculture, Fisheries and Food. The meeting was held in the Wellcome Building, London.

The symposium, which was arranged under the successive chairmanship of F. P. Coyne, B.SC., PH.D., of Imperial Chemical Industries, R. W. Marsh, M.A., of Long Ashton Research Station, and R. A. E. Galley, PH.D., D.I.C., F.R.I.C., Director of the Colonial Products Research Association, was attended by about 200 members of the Society. The following is a short summary of the papers given at the conference.

Concentrate Spraying — Fungicidal Aspects *by M. H. Moore* (*East Malling Research Station*).

A series of intensive experiments on well-replicated single-tree plots of small Cox's Orange Pippin trees, based on lime-sulphur applied by a paint-gun, was designed to elucidate the role of spray (*a*) volume, (*b*) concentration, and (*c*) dosage in the control of Apple Scab and Powdery Mildew and the incidence of spray damage. Disease control increased with increasing dosage up to the point where phytotoxicity proved to be a limiting factor; maximum safe dosages were, however, achieved by the highest concentrations at the smallest volumes.

Orchard Trials with Undiluted Lime-Sulphur *by H. H. Glasscock* (*N.A.A.S., Wye*).

In 1954 and 1955, trials were carried out in two commercial orchards of Cox's Orange Pippin apples in Kent and Cambridgeshire to compare the effects of undiluted with diluted (high volume) lime-sulphur applied an equal number of times with the following results.

Leaf Scab was either absent or negligible in both orchards. With Fruit Scab, control appeared to be at least as good in the concentrate plots as in those sprayed at high volume. Mildew (primary and secondary) was less on the concentrate plots in one orchard in the second year, presumably as a result of the first year's spraying. Red Spider was less in the concentrate plots in one orchard in one year. Leaf Scorch, Leaf Drop and Fruit Drop were generally negligible in both treatments in both orchards. There were no differences in degrees of Russeting.

High- and Low-volume Spraying in Potatoes and Pine Plantations *by G. R. Nitsche and J. Vogel* (*Norddeutsche Affinerie, Hamburg*).

Cuprous oxide is more rain-resistant than copper oxychloride, in both cases the rain-resistance increasing with decreasing particle size.

In rows of potatoes which are still open, the spray deposit on the upper leaves is about twice that on the lower leaves. When the rows have closed, much less is deposited on the middle and lower parts, the approximate ratio being: Upper : middle : lower = 100 : 50 : 20.

In forestry trials, low-volume deposits (*sprüten*) proved considerably more rain-resistant than high-volume deposits (*spritzen*). Low-volume application is, therefore, preferred for the control of Pine Blight (*Lophodermium pinasti* Schrad).

Three years' trials on the control of Pine Blight show that knapsack sprayers give the best results, up to a height of 80 cm. Over 80 cm., the helicopter method is preferred.

The Development of Low-volume Spraying Methods with Special Reference to Fruit *by J. H. Stapley* (*Plant Protection Ltd.*).

Low-volume spraying of apples is now well established; at least 20,000 acres being treated at rates from 20–50 gal. per acre in 1956. For application, air-blast machines are essential, of which there are now many makes available.

Information from trials and commercial experience has shown that spraying at low-volume rates can give control of Apple Scab, Fruit-tree Red Spider, and insect pests, equal to the best high volume. Grade-out figures have shown that the crop is equal in quality following low volume as that following conventional spraying.

The great advantage of the low-volume spraying technique over conventional methods is in the saving of time and labour. Orchards which formerly required up to 20 man-hours for spraying can now be sprayed with less than one.

Summary of the Commercial Value of Various Low-volume Techniques Used in Fruit-tree Spraying *by D. Hunnam* (*The Murphy Chemical Co. Ltd.*).

Three techniques for low-volume applications have been examined in commercial orchards over the past three years, viz.:

1. Air-blast spraying at about 50 gal./acre.
2. Mist blowing at about 20–35 gal./acre.
3. Concentrate spraying at about 3–6 gal./acre.

The author's conclusions are that the air-blast technique is here to stay and provides really reliable control. Mist blowing at 20-30 gal./acre appears to be of a similar order of reliability with the disadvantage that it may not be wise to spray mercurial preparations at this volume and concentration.

In his opinion, the commercial grower should be equipped for both high- and low-volume spraying which in effect means that the same machine should be capable of spraying at both rates.

Levels and Distribution of Deposits *by J. T. Martin* (*Long Ashton Research Station*).

Work at Long Ashton over the past few years on the comparison of large- and small-volume spraying is described. Particular attention has been given to the nature and levels of deposits from different treatments, so that the dosages found on the targets may be related to the spraying techniques used and the degree of control obtained.

The methods used for the examination of the nature of deposits are described. Comparisons are also given of the levels of deposits, including drift, obtained in the large- and small-volume spraying of potatoes and bananas with copper, and of fruit trees with DDT and captan.

Spraying Techniques *by H. G. H. Kearns* (*Long Ashton Research Station*).

The importance of a precise knowledge of the spray target is discussed, especially its biological, chemical and physical properties. The role of the spray programme and the factors that decide the choice of a spray technique are given. The classification of spray techniques is discussed and one based on performance is suggested. A brief review is made of the various spraying methods, including lance, automatic hydraulic machines, airflow machines using hydraulic and other methods of atomisation. The advantages and disadvantages of machines of various specifications are pointed out.

The factors determining the choice of a spray method and machine in relation to the type of crop are discussed. References are made to various fruit crops including soft fruit, plums, apples, pears and some tropical crops. Views are given of the present status of spraying methods and of their future development.

Droplet Formation and Assessment *by J. B. Byass* (*National Institute of Agricultural Engineering*).

The paper deals with the aspects of drop formation particularly related to forming crop-protection sprays. It is pointed out that in this context the means of breaking up the liquid must be related to the means of conveying the spray to the crop. The degree of atomisation required is governed by the amount of liquid to be used, which is in turn determined by the concentration in which it can be used and economic factors in the application. The limitations of hydraulic pressure nozzles are discussed and characteristics of various twin fluid atomisers and rotary atomisers given. These results are discussed in relation to their practical application to tree crops, ground crops and drift spraying. The distinction is made between tree spraying, where formation of the spray is a secondary problem to that of projecting it into the crop, and other types of spraying where spray formation is the prime function of the machine.

Development of Air-assisted Fruit-spraying Machinery *by L. C. Pearch* (*Kent Engineering & Foundry Ltd.*).

The author feels that the development of low-volume spraying is a very recent event and it has raced ahead of scientific research because the grower has felt the need to reduce costs to match up with the diminishing selling price of his products, but that he has not necessarily obtained his goal, for it appears that more chemicals per acre are applied at low volume than are required for high-volume spraying.

He considers the air-assisted spraying machine as falling into three categories:

The first with 100-m.p.h. air speed and ample volume and horse-power that enables the machine to spray from 500 gal. per acre down to 30 gal. per acre.

The second type of machine employs 150-m.p.h. air speed with less volume of air and with less horse-power, i.e. driven from the power shaft of the hauling tractor. This type of machine has a capacity for spraying from 250 gal. per acre down to 20 gal. per acre.

The third class of machine under consideration is one which employs an air speed of 240 m.p.h.—this type of machine has a capacity from 50 gal. down to 3 gal. per acre. The high air speed is used to atomise the spray in the outlets, in the place of a swirl nozzle as in the previous two.

The Application of Low-volume Spraying in East Africa *by A. E. H. Higgins* (*Imperial College Field Station*).

The application of pesticides in the various fields of control work in East Africa is generally speaking confined to the use of dusts or low-volume spray application. Water supplies are very scarce and often have to be carried considerable distances, especially for the control of agricultural pests and in tsetse and mosquito control. Insecticidal or fungicidal dusts applied with simple applicators are not entirely satisfactory, as they are often washed off the foliage very soon after application by heavy showers of rain, or removed by wind.

Most of the spraying at present is carried out by either hand sprayers or knapsack sprayers and the advantages of the various types are discussed. The choice of machines is governed to a great extent by the kind of terrain or the conditions under which the spraying has to be carried out. Very little work has been carried out on the suitability of the various kinds of machine for use in East Africa, but it seems likely that the motorised knapsack-mistblower will become widely used as well as perhaps the small stretcher-carried mistblower. Tractor-mounted or -trailed machines are restricted in use because of the low clearances involved and the damage caused to the crop. Furthermore, large tractor-trailed machinery is liable to become bogged down or stuck on slopes. Another difficulty in the use of such machines is that damage may be caused to the ridging used to conserve either water or soil. Many crops are not grown in straight lines with regular spacing between plants, and in some, shade trees are required which cause added complication in the use of tractors. Limited maintenance and repair facilities along with the difficulty of obtaining spare parts makes it essential that robust and well-designed machines are used. Simplicity of operation is essential for African use, as these peoples have virtually no mechanical background and require lengthy training and adequate supervision.

Large-scale Application of Low-volume Sprays to Fruit Trees *by K. G. Chandler* (*Land Settlement Association Ltd.*).

Low-volume methods permitting substantial reductions in time and materials have been investigated over a number of years in an orchard comprising over 300 acres of top fruit, mainly apple.

The method chosen was to apply 50 gal. per acre and to increase the concentration of the spray materials from three to five times. Advantages of the system are that considerable savings are effected without the need for concentrating the more toxic chemicals, such as mercury, beyond the danger limit for the operator.

Large air-blast machines with tanks of 450-gal. capacity have been used throughout, and, after numerous trials, the Lyunet nozzle has been standardised as the most suitable. Conventional air-blast sprayers are capable of producing the medium-sized droplets required for this technique, without expensive modification.

Control of pest and disease, using all the usual chemicals, has been found equal in all respects to that obtainable by high-volume methods and although liquid and colloidal formulations have been found more convenient from the point of view of mixing, powder suspensions have been used with equal effect.

NEW PUBLICATIONS

The Storage of Seeds for Maintenance of Viability

This Bulletin, No. 43, prepared by the Commonwealth Bureau of Pastures and Field Crops, is a review of literature concerning the storage of valuable genetic material (seeds), which would serve as a guide for plant breeders in the U.K. Amongst other things, it deals with the storage of small quantities of seeds against loss of viability.

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Revue Agricole Sucrière et Rhumière des Antilles Françaises

We have received from the Centres Techniques de la Canne et du Sucre de la Guadeloupe et de la Martinique No. 1, Vol. 1, of the quarterly review entitled *Revue Agricole Sucrière et Rhumière des Antilles Françaises*. Amongst the articles is a work by Dr. C. Van Dillewijn on the 'Evolution and Growing of Cane in the French Antilles' and others concerning the place of sugar in the economy of Guadeloupe and of Martinique. An account is also given of the varieties of sugar-cane in the French Antilles.

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Farm Management Manual

This is sub-titled 'A Guide to Reorganising a Farm', written by T. R. Hedges, Professor of Agricultural Economics at the University of California, and G. R. Sitton, Assistant Professor of Agricultural Economics at Oregon State College, and published by the National Press, California. The manual is designed in the form of a laboratory course in farm management and the authors present detailed procedures for planning and organising the farm as a business. Detailed record and analysis sheets are supplied, together with instructions and references. The material is organised in the form of 14 problems, each with an accompanying exercise for the student to complete. Price $3.00.

*

European and Mediterranean Pests

We have received from EPPO a set of colour plates illustrating 10 pests and diseases of special danger to Europe and the Mediterranean area. The colour plates, which have been described as excellent by authorities in the U.S.A., can be obtained on application to EPPO, 142 avenue des Champs-Elysées, Paris (VIIIe). Price 200 F. fr.; 4*s.* 0*d.*

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Cacao

The Inter-American Cacao Centre have reported in their journal *Cacao* on the symposium on the control of insect diseases and pests of cacao at the Instituto do Cacau da Bahia, Salvador-Bahia. A total of 60 technical papers was presented and these have been abstracted in Vol. 3, No. 11, of the journal.

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FAO Publications

Pastures and Fodder Crops in Rotations in Mediterranean Agriculture. In order to assemble information on the progress achieved in the Mediterranean area in the development of rotations incorporating annual or perennial legumes, other fodder crops and pastures, the author of the present document, Mr. P. A. Oram, makes a special study of the subject and has presented an analysis of the problems for further consideration. The main headings of the work are: 'The Basic Farming Pattern in the Mediterranean Area at the Present Time', 'Problems in Research', 'Economic and Social Problems' and 'Extension and Education'. Price $0.50; 2*s.* 6*d.*

World Grain Trade Statistics. This is presented in two parts, Part I of which supplements the FAO Trade Yearbook and shows tables of world trade in grains for the years 1954–55 and 1955–56. Part II is the continuation of the previous publication, 'Grain Exports by Source and Destination', and shows exports of selected countries by destination. Price $0.25; 1*s.* 3*d.*

Water Lifting Devices for Irrigation. This booklet, prepared by Aldert Molenaar, irrigation and drainage specialist, describes and illustrates the main types of devices used to raise water for irrigation in the rice-growing countries. The use of the devices has not, however, been restricted to rice-producing areas or rice irrigation only. Some of the devices described may be used or adapted for use with crops other than rice. This booklet is profusely illustrated. Price $1.00; 5*s.* 0*d.*

Other publications include *Joint FAO/WHO Conference on Food Additives*, price $0.30 or 1*s.* 6*d.*; *Selected Problems of Production and Trade in the Near East*, price $1.75 or 8*s.* 9*d.*; and *Food and Agricultural Legislation*, 1956, Vol. V, No. 2, which deals with land tenure and land reform in French Oceania, Guatemala, Portugal, Spain and Yugoslavia, and forest services in Czechoslovakia.

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Empire Cotton Growing Corporation

We have received copies of Progress Reports from the Sudan and Kenya Experiment Stations for the season 1955–56.

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Other Publications

We have received copies of the following publications:

The Institution of British Agricultural Engineers Year Book, 1956–57. This publication contains summaries of papers read at meetings of the Institution throughout the year.

Annual Report on the East Africa High Commission, 1955. London: H.M.S.O. 1956. Price 5*s.* 6*d.*

Census of Agriculture, 1952, *Part IV—Agriculture*. Ceylon: Government Press. 1956.

Food Research Institute of Stanford University Report for 1955–56.

Library Resources in the Greater London Area. No. 5, *Agricultural Libraries*. London: The Library Association. Price 4*s.* 6*d.*

Frankenwald Field Research Station Annual Report for 1955.

The Control of Pests and Diseases of Farm and Market Garden Crops. A revised edition of the Murphy Chemical Company's booklet has recently been issued and announces the introduction of several new products, including Crestol, a pre-emergence weedkiller.

Visiting Far East

Mr. G. H. Wilkinson, of H. J. Stockton and Co. Ltd., export agents for a number of leading British manufacturers of agricultural machinery and equipment and of agricultural chemicals, will be visiting a number of countries in the Far East during the first three weeks of February, stopping at Calcutta, Dacca, Rangoon, Singapore and Hong Kong.

MACHINERY AND EQUIPMENT

New Device for High-standing Crops

The latest development by Silorators Ltd. is a device of particular interest to the export markets, since it is a unique means of harvesting high-standing crops which are hardly grown at all in Britain. This device, the rowcrop attachment for the 'Silorator', has on trials cut maize and topine standing 12 to 14 ft. high.

Demonstrations in the field of this device are shortly due in France, Belgium, Germany, Austria and Switzerland, with a follow-up on the African continent. Advance reports state that if the maize-cutting operation is up to specification, then Germany alone will require considerable numbers of 'Silorator' harvesters per year.

Applications

Foreign applications extend far beyond the home use for which the 'Silorator' was originally developed. It has been used for spraying fruit trees and is actively under consideration for pineapple trash in South Africa and attack on the boll weevil in Egypt. In New Zealand particular success has been achieved in its application as a harvester of clover seed. By a simple fitting of sacking to collect the seed from growing clover, and an adjustment of the cutting heigh with the cut.ing knives removed, the clover seed is gathered in splendid condition and gives excellent results on sowing.

Motorised Knapsack Sprayer

A new motorised knapsack sprayer and duster is claimed by its makers, the Hart Agricultural Engineering Co. Ltd., to spray better, faster, and with greater penetration and efficiency than any conventional spraying equipment. The spray may be in heavy or light applications and in different patterns, according to requirements.

It is a remarkably simple, compact and well-balanced unit, with a low centre of gravity and a net weight of only 35 lb. It is easy to clean and maintain as there are no valves and no pump, and the 49-c.c. Teagle engine is quickly detachable.

Reader Service

For further information on any item of machinery or equipment reviewed in this section please write to:

Reader Service,
WORLD CROPS,
Stratford House,
Eden Street, London N.W.1,
England

New Carburettor

A new carburettor, with the air cleaner forming an integral and unobtrusive part of an extremely neat and compact assembly, has been designed by the Villiers Engineering Co. Ltd., England, and will be fitted initially to their Mark 10 and Mark 12 four-stroke agricultural and industrial engines.

Apart from the technical changes that have resulted in improved carburation, an outstanding feature of the new carburettor, which is listed as the B10, concerns the air filtration. Two types of filter are available, one an oil-wetted and the other an oil-bath model. Both have their own adaptors, which are fitted by two screws to the base of the carburettor. The arrangement forms a complete streamlined assembly and in consequence both carburettor and filter are far less vulnerable to damage. Both types of filter, too, can be removed for routine cleaning and maintenance and refitted simply and quickly without any tools being required.

Air cleaning

The oil-wetted filter unit consists of a galvanised knitted-wire mesh contained within an open-work plastic moulding. It is secured by two spring clips and only requires washing in petrol and immersing in thin oil at regular intervals to ensure satisfactory air cleaning.

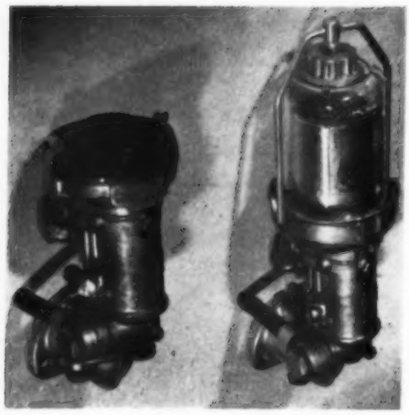
The oil-bath filter for use in dust-laden atmospheres has the same location as the oil-wetted unit, attachment to its adaptor being by a strong wire clip and a turn-buckle screw. The cartridge-type filter element is supported within a transparent plastic bowl, which is flexible enough to absorb knocks and prevent breakage.

A mark on the moulding indicates the correct level of oil, and as the oil is visible within the container its condition and quality can always be seen. Removal of the bowl and filter element for cleaning and replenishing and refitting can also be carried out in a few moments.

Flooding

The danger of the oil being diluted by petrol in the event of flooding is eliminated by the provision of a ledge in the adaptor which diverts the petrol

The Micro-Hart motorised knapsack sprayer can be adjusted to spray heavy or light applications in different patterns according to requirements



Villiers B.10 carburettors, the model on the left being fitted with an oil-bath filter and that on the right with an oil-wetted gauze-type filter

away from the bowl to a porous sintered-bronze drain plug.

The carburettor body is comprised of two light-alloy castings, the upper portion being common to all sizes of carburettor, and the lower part having bores to suit the capacity of engine to which it is to be fitted.

Carburation with petrol

In the upper section of the carburettor a taper screw provides adjustment for the mixture from the pilot jet, a second screw providing slow-running adjustment. The fuel needle-valve assembly is a separate unit which screws into the underside of the body. This enables replacement units, if necessary, to be fitted without difficulty. The normal type of banjo fitting for the petrol pipe incorporates a cylindrical-pattern fuel filter.

The lower portion of the carburettor body is comprised of the float and mixing chambers. The pilot jet is screwed in from the top face, the fixed main jet being located in the side of the casting. A spring-loaded strangler lever and plate are fitted below the venturi.

Carburation with oil

Models fitted to engines running on vaporising oil are provided with an outlet hole for drainage purposes below the bottom of the float chamber, control being by a drain screw.

Carburettors will be correctly tuned on the engines before leaving the factory, but minor adjustments that may become necessary can be effected by means of the screw controlling the air mixing with the fuel supply from the pilot jet. The slow-running control is very easily adjusted, the throttle-stop screw being located on the carburettor body instead of on the throttle lever as on existing types.

The main jet is easily removable for cleaning being accessible on the outside of the carburettor body. Cleaning the pilot jet involves detaching the bottom half of the carburettor, but this merely calls for the undoing of two screws, and the operation can be carried out without disturbing the governor connections.

Airflow Meter

To meet the need to measure air flow when drying stored grain, the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, have designed an airflow meter, which is manufactured by C. F. Casella and Co. Ltd., England.

Although this meter has been primarily designed for use on grain in farm silos, it can be used for other measurements of air flow as well. For instance, essentially the same problem is met by maltsters, who, during the various drying processes on the barley, pass heated air through the porous floor of a kiln and then through a layer of barley. In many cases the air movement is entirely by natural means; that is, the rising heated air passes through the barley and escapes *via* louvres in the roof. Often, however, fans are installed in the roof, which materially increase the air movement. In both cases the air flow per unit area is very small and difficult, if not impossible, to measure by any other means than with this airflow meter.

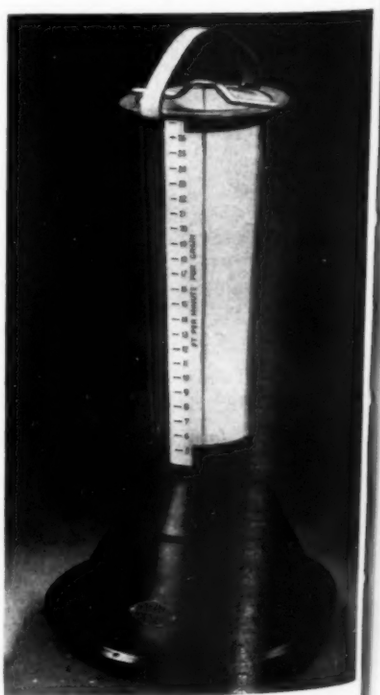
The airflow meter can be used on other types of grains or seeds which are dried by passing air through them; also on peas, beans, hops etc., where the same problem arises. It is not advisable to use it on very small seeds or material containing a lot of dust, since small particles tend to get in the central hole and prevent easy movement of the float.

In use all that is necessary is to place the meter on the material, press it down until the flange is level with the surface and read the height of the float against the scale. This scale is engraved directly in ft./min. of air flow and for the usual grains, such as wheat, barley, oats, maize etc., no corrections are required.

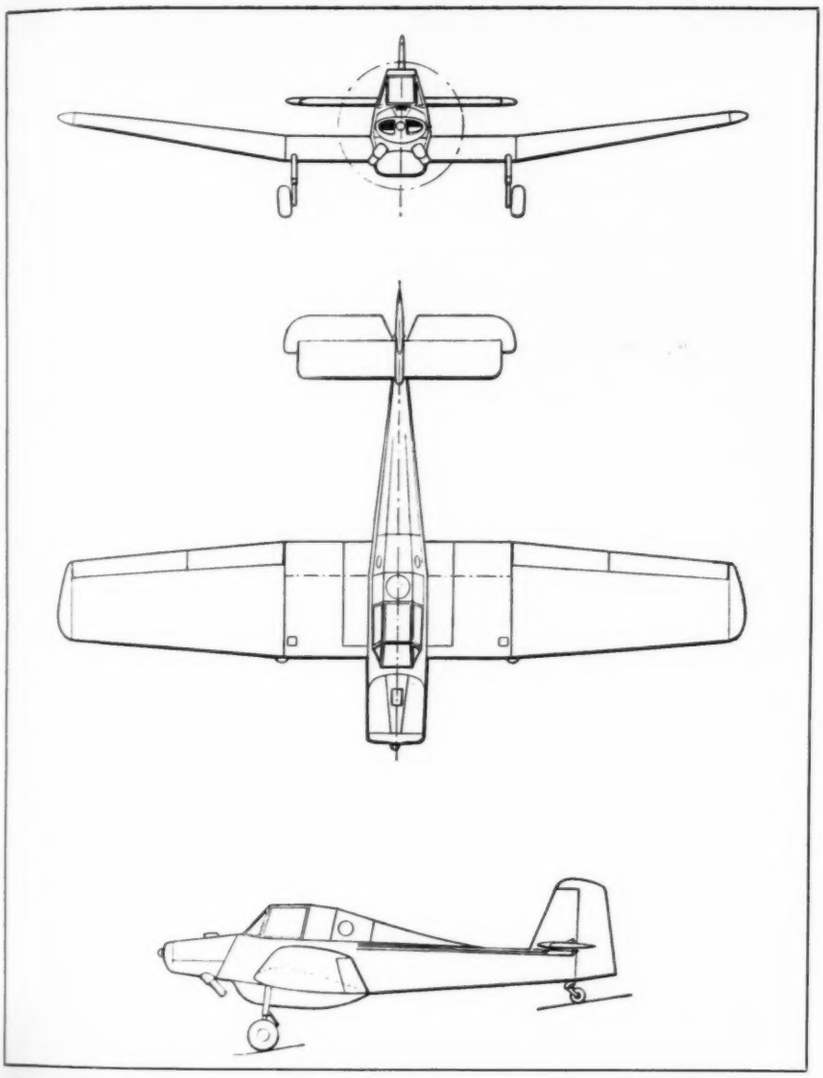
Although the scale is calibrated for air driven up through grain in lineal feet per minute, the makers can supply to special order a calibration expressing the total volume of air from a pipe or duct in cu. ft./min. A minimum flow of about 2 cu. ft./min. can be achieved. By substituting heavier floats the maximum flow can be raised, but only, however, at the expense of the minimum flow.

The airflow meter consists of a tapered transparent plastic tube in which a very light aluminium disk is constrained to move centrally up and down by a fine wire passing through a guide bush fixed to the centre of the disk. Air passing up the tube supports the weight of the float at a position where its weight is exactly balanced by the pressure drop and drag of the air as it passes the varying annular space between it and the tube. The disk is provided with notches near the edge, which cause it to rotate slowly and eliminate any tendency for it to stick. The tube is 12 in. long and tapers from a diameter of $3\frac{1}{16}$ in. at the bottom to 4 in. at the top, the float diameter being 3 in.

The height of the float is noted against a scale engraved on the tube. The range of air flows which can be measured is from about 6 ft./min. up



The scale on the airflow meter is calibrated for air driven up through grain in lineal feet per minute



The Auster ' Agricola ' incorporates a simple-to-inspect system of control cables to the tail unit. There are no panels to unscrew and no fabric to cut, as the cables are passed along the outside of the fuselage at eye level

to about 26 ft./min., which is adequate to cover the range of air flows likely to be met on farm silos. To assist easy reading of the float position in poor light the rear half of the tapered tube is made of white opaque material which gives a good contrast for the scale.

To provide adequate total air flow and to minimise errors due to local areas of non-uniform grain or the presence of any trash not removed by the dresser, an aluminium collecting cone 9 in. in diameter is provided. A horizontal flange is formed at the lower end of the cone which supports the meter on the grain surface while a short vertical spigot (which minimises the leakage of air from the pressurised region below the collecting cone) projects downwards into the grain.

Auster ' Agricola '

The Auster ' Agricola ' was one of the first aircraft in the world to be designed specifically for topdressing (aerial fertilising) and other agricultural operations in countries like New Zealand. It has been produced after careful study by Auster engineers of the exact operational requirements of scores of topdressing units.

Its ability to perform aerial agricultural work cheaply with the maximum safety stems from many features unique to the ' Agricola '. New corrosion-resisting paints and dustproof ' sealed in ' airframe units lead to a prolonged operational life. Pilots will find its cockpit layout pleasingly simple—and consistent with the aircraft's duties. Only the most essential instruments and equipment are fitted. Non-tiring, power-assisted hopper and flap controls, plus a superb field of vision, lead to improved pilot efficiency—and much safer flying.

Following Auster tradition, the ' Agricola ' is versatile and not limited to the single role of topdressing—with a restricted earning capacity. It is suitable for all agricultural work, including spraying, dusting, fence and supplies dropping, aerial baiting and light freighting.

Fuselage structure

This is built from welded tubular steel and for ease of repair in the field the rear section is fabric covered. The hopper filling trunk is positioned behind the pilot, ensuring that no dust is blown on to the windscreen during filling, even though the engine is running. Aft of the trunk is a two-seat passenger compartment in which ground crew may be carried.

Extra safety is built into the ' Agricola ' with the sealing of the rear fuselage. This prevents the ingress of dust or superphosphate which can otherwise lead to tail heaviness and dangerous flying characteristics. Special filters are fitted to counter any change in humidity and atmospheric pressure.

For easy engine and cockpit servicing, the entire front fuselage can be uncovered in minutes through the use of quick-release metal panels.

Cockpit

The very nature of topdressing and spraying work demands a structure around the pilot capable of withstanding high crash loads. The cockpit, therefore, has a tough structure designed to give pilots the maximum of protection, especially in the event of the aircraft turning over. For greater strength the pilot's seat is integral with the wing centre section structure. A robust shoulder harness affording extra protection is made of a material resistant to the corrosive effects of most powders and spray liquids.

Visibility from the cockpit is excellent. The top cowl line of the nose is sloped downward away from the windscreen, providing an unimpaired forward view. Even when the aircraft is in the tail-down position the nose remains below eye level, greatly reducing the risk of taxi-ing or low-flying accidents.

Permanent clear vision is ensured through the fitting of toughened glass panels in the windscreen—to resist scratching caused when cleaning off abrasive dusts and phosphate. The remaining transparent panels are of simple flat ' perspex ' sheets, thus no expensive moulded canopies need be held as spares. Sliding panels give controlled ventilation in flight, and an efficient windscreen wiper provides excellent visibility in bad weather. Once the pilot's canopy is closed the cockpit is c mpletely sealed against the ingress of any fertiliser spilt whilst loading.

In keeping with the overall simplicity of the aircraft, the instrument panel contains only the most essential instruments: an engine speed indicator, boost gauge, sensitive altimeter, oil pressure gauge, fuel pressure gauge, oil temperature gauge, compass, ignition switches and two air-speed indicators.

Hopper and spray tanks

Many months before the ' Agricola ' first flew intensive flight dropping trials were carried out with various types of hoppers fitted in development aircraft. Pilots' and observers' reports were closely studied to select the most efficient hopper shape and this has been built into the ' Agricola '.

Even greater daily loads of phosphate can be dropped with this hopper, which can be packed with 1,680 lb. of fertiliser. Pilot fatigue is lessened by the hydraulic actuation of the hopper doors. Eight-inch lumps can pass through the doors, which are hydraulically powered and controlled by a finger-tip lever close to the pilot's left hand. Hopper life is lengthened through the plastic interior lining. Hopper filling can be accomplished in seconds. A loading operator can use the low wing as a walkway and guide the loading funnel quickly into position above the 18-in.-dia. filling trunk. In emergencies the entire load can be dumped within five seconds.

Pressure-regulating Valve

This valve, which was introduced by Cooper, Pegler & Co. Ltd., can be set to give any constant pressure, as desired, between 30 and 70 lb./sq. in. and is accurate to within ±2 lb./sq. in.

It was designed for use with spraying equipment and enables the contents of pneumatic sprayers to be discharged at a fixed pressure, thus giving uniform coverage and a saving of insecticides, fungicides etc., time and labour, as the contents of the sprayer are discharged more slowly.

The Cooper, Pegler pressure-regulating valve, designed for use with spray equipment

It is made of brass and is fitted with springs and a diaphragm, all of which are resistant to any of the chemicals used for spraying at the present time.

Though normally supplied set at 50 lb./sq. in., this setting can be fixed to suit users' individual requirements or is easily adjusted to provide any other pressure required.

Revolving Drum Mixer

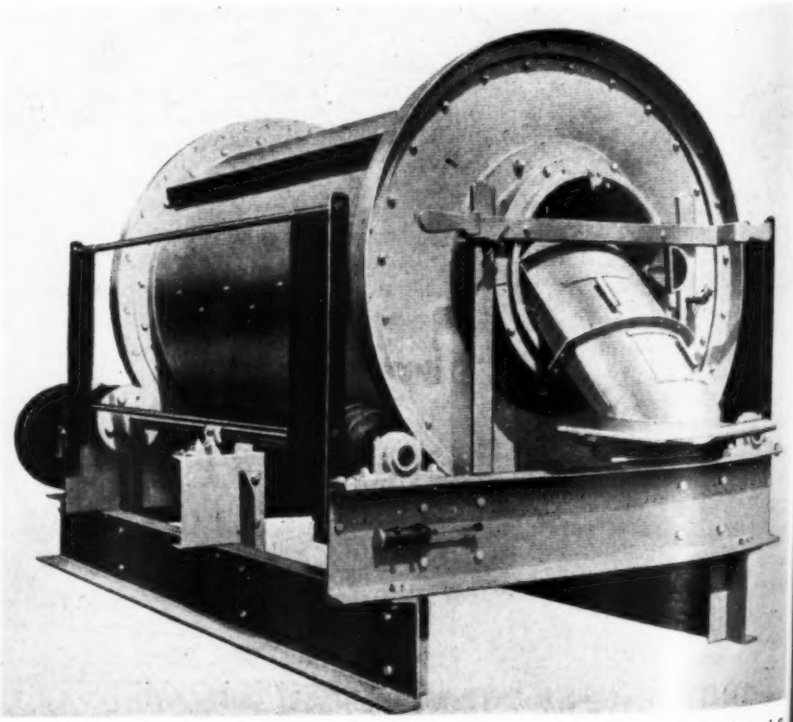
This totally enclosed, dustless batch mixer, which can be supplied lined for protection against chemical corrosion, and which has a gentle but thorough mixing action, is manufactured by the British firm, J. Booth and Son Ltd.

Mixing action

Two independent movements of the material take place, one from bottom to top and one from end to end. There is nothing in the mixing action to cause damage to any materials being mixed. Owing to the unique action of the Booth revolving-drum mixer, blending of the most difficult materials is accurate, thorough and rapid. Materials of varying densities and of varying granular sizes may be blended or mixed.

The mixer is supplied for mixing fertilisers, insecticides with cotton or other seed, salts, minerals, compounds, anti-locust bait, grass and clover seed, tea, colours, asbestos fibres, synthetic resins, soap powders, detergents, bakelite etc.

The standard machine is supplied as illustrated, with self-contained electric motor drive. It may also be supplied with an internal combustion engine and fast-and-loose pulleys for flat belt drive.



The totally enclosed, revolving Booth drum mixer can be used with materials of varying densities and granular size

Agricultural Chemicals

Weedkillers : Insecticides : Fungicides : Fertilisers Seed Disinfectants

'TRIOXONE', a product of Plant Protection Ltd., is a 2,4,5-T hormone selective weedkiller for the control of certain species of woody weeds and trees. It is readily miscible with water or oil, including diesel oil, tractor vaporising oil, gas oil or kerosene.

It is claimed that the use of 'Trioxone' is particularly useful against weeds such as blackberries and gorse in pastures and rough grazing. It may be used for scrub clearance of headlands, ditches, dykes, forest firebreaks, and when reclaiming marginal lands. If regrowth occurs in the same season or in the year following application repeat treatment should be made. This weedkiller is harmful to clovers and swards with a high clover content should be sprayed with care. Spot treatment may be preferable to overall spraying in such cases.

The weeds controlled by 'Trioxone' include alder, elder, hazel, willow, blackberry, birch, gorse, chestnut and hawthorn.

*

The selective weedkiller 'Tropotox' (May and Baker Ltd.) has in two seasons' widespread use given safe and effective weed control in clovers undersown in cereals, direct-seeded clovers, both young and established leys, permanent pastures with high clover content, and some important varieties of peas. Moreover, there are indications for its trial use in celery, sainfoin and white clover, grown for seed. 'Tropotox' contains 40% of MCPB active acid equivalent.

*

Chemical Insecticide Corporation have announced the introduction of 'Chem-Vape', a new one-shot treatment for the control of weeds and soil-borne insects and diseases. 'Chem-Vape' is a dithiocarbamate liquid which results from C.I.C.'s continuing research in carbamate products. Chemical Insecticide Corporation is a basic manufacturer of dithiocarbamate fungicides, including 'Nabam' and 'Zineb'. One application of 'Chem-Vape' properly applied before planting will ensure effective control of the various grasses and broad-leaf weeds, including the seeds of these vegetative pests. This same application will also destroy nematodes, insects and fungi which are found in the soil.

'Chem-Vape' has a low toxicity to warm-blooded animal life. Preliminary reports indicate wide possible usage in seed beds of cauliflower, cabbage, egg plant, lettuce, ornamentals, strawberries, tobacco, tomatoes and other crops. 'Chem-Vape' leaves the soil in a relatively short period of time, thus permitting the treated areas to be planted the same season.

*

Annual grasses, such as crabgrass, watergrass and foxtail, and established perennial grasses, such as quack grass, blue grass, para grass, Alexander grass, Bermuda grass, Johnson grass and phragmites (giant reed grass), and also cattails can be controlled by 'Dowpon' (Dow Chemical Co.), a herbicide containing 85% of the sodium salt of 2:2-dichloropropionic acid.

It is most effective when used as a foliage spray, although it may also be absorbed from the soil through the roots of the plants. It can also be used in combination with certain other herbicides to destroy the broad-leaved weeds as well.

It is recommended that it should not be applied during a dry period and that the planting of the main crop should be delayed for 40 days after the treatment, so as to allow the herbicide to decompose in the moist soil.

*

'Guesarex' is a multi-purpose garden dust, effective not only against most of the common insect pests, including aphides, but also against fungal diseases. It thus gives the gardener a first-rate weapon against many troubles in the garden. Among other ingredients, 'Guesarex' contains dimetan, the new aphicide discovered and developed by the Geigy Co. 'Guesarex' is safe to use and simple to apply from the new puffer pack, which does away with the need for expensive spraying apparatus.

'Guesarex' was developed by the Geigy research organisation, which gave the world the first of the synthetic insecticides, DDT. 'Guesarex' is a combination of compounds effective against insects of the beetle, fly and caterpillar type, against aphides (greenfly, blackfly etc.) and against fungal diseases.

An important ingredient of 'Guesarex' is dimetan, also a Geigy discovery, which is extremely toxic in very small quantities to aphides. Dimetan has proved, for example, outstandingly successful against the bean aphis (*Doralis fabae*).

*

Trials of a new type fertiliser are being made in parks under the control of the London County Council.

Impressive reports of the successful use of this new fertiliser ('Sustanum Quick Feed'—Trace Element Fertilisers Ltd.) have been received from commercial growers both in this country and abroad and now the effect on the grass in Holland Park during June and July has been observed. A 'Sustanum' strip continues to show very marked improvement in growth and colour, despite heavy rainfall, and the root action has been greatly encouraged.

The makers claim that an application of 1 oz. per sq. yd. would be sufficient for average turf and the number of applications could be drastically reduced—in most instances one application per year would probably be sufficient. Apart from the improvement in growth, there is considerable saving in labour.

*

Although there has been a 56% increase in agricultural produce in Britain since 1938, which has been mainly stimulated by the use of fertilisers, the general shortage of nitrogen is one of the problems of British agriculture today. Since at present there is not enough nitrogenous fertiliser to supply the market, Shell Chemical Co. have decided to import considerable quantities of their new fertiliser, 'Nitra-Shell', from Holland until their proposed £6½-million plant in Britain begins production.

'Nitra-Shell' is a granular nitrogenous fertiliser with a guaranteed nitrogen content of 20.5% and 36% carbonate of lime. This makes it one of the most concentrated nitrogenous fertilisers available in Britain. The

main use of this new product will be as a top dressing and grass and green fodder crops will benefit especially.

Since such solid fertilisers can readily absorb moisture from the atmosphere, the manufacturers have designed an especially effective package which consists of a five-ply paper bag which includes one-ply bitumen lining and one-ply polyethylene lining. The polyethylene lining gives extra protection from damp, as it is not as liable as bitumen to become hard and crack. Thus the product will be preserved during storage and up to the time of use.

*

In cotton production U.S. agricultural scientists have found that producing a bale of cotton without benefit of modern technology requires 155 man-hours per season, whereas complete application of modern technology to all phases of cotton production could reduce this requirement to 10 man-hours or possibly less. Machinery for planting the seed and harvesting the crop has played an important role in this trend, as well as mechanical cultivation to control weeds after the cotton plants are well started.

There has been a high labour requirement for a short season each year to thin or ' chop ' cotton and to hoe away the weeds until the cotton plants grew large enough for safe use of mechanical cultivation. Thinning or ' chopping ' has been necessary in the past because cotton has been deliberately over-planted to ensure enough seedlings to make a crop. Modern planting methods and chemical treatment of the cotton seed with ' Granosan ' seed disinfectant have made this over-planting unnecessary. And now, in the U.S.A., there is every indication that hoeing for weed control can be eliminated by application of new chemical weedkillers, such as ' Karmex ' DL herbicide, at planting time (called pre-emergence application because the chemical is applied before seedlings of either weed or cotton emerge from the ground). ' Karmex ' DL herbicide is being used in the U.S.A. for pre-emergence weed control in non-irrigated cotton. Mid-season applications of a related material, ' Karmex ' W herbicide, are recommended for irrigated cotton in Arizona. These three products are manufactured by E. I. du Pont de Nemours and Co.

Pre-emergence weed control

Most of the chemical weed control pre-emergence applications in the U.S.A. are on fields in the relatively high rainfall areas of the Mid-South Delta. The flat terrain and large continuous cotton fields make it efficient to use machinery and tractors wherever they will do the job. Much of the cotton in this area is grown without irrigation.

Weed control reduces hoeing

Pre-emergence weed control with chemicals has substantially reduced the need for hand-hoeing in many of these Mid-South fields. In some cases hoeing has been entirely eliminated or replaced with a single thinning operation.

U.S. cotton acreage treated with ' Karmex ' DL herbicide totalled over 9,000 acres in 1954 and was increased substantially in 1955, in spite of a reduction in total planted acreage and abnormally dry weather at planting time.

Most U.S. growers reported generally good control of the seedlings of such weeds as crabgrass (*Digitaria sanguinalis*), pigweed (*Amaranthus* spp.), purslane (*Portulaca oleracea*), barnyard grass (*Echinochloa Crus-galli*) and lambsquarter (*Chenopodium album*) at appreciable savings over hand hoeing. Control lasted from three to eight weeks.

In areas where it is customary to cultivate across the field as well as lengthwise (called cross-ploughing), some planters have tried chemical treatment as insurance against wet weather. They treated a smaller-than-normal band of soil along each row and thus held back weed competition at little cost in fields that were too wet to use machinery for early cultivation.

*

Reader Service

For further information on any item reviewed in this section please write to :

Reader Service
WORLD CROPS,
Stratford House,
Eden Street, London N.W.1,
England

Test results now show that ' Crag ' Brand glyodin (Carbide and Carbon Chemicals Co.) can be used throughout the apple season for scab control in a standard spray schedule and applied *even on the day of harvest* without exceeding the residue tolerance established under the U.S. Federal Food, Drug and Cosmetic Act. The maximum probable residue (and the tolerance) is five parts per million, by weight of the fruit. When ' Crag ' glyodin is applied in accordance with the directions on the label, the usual residue at harvest is less than one part per million.

' Crag ' glyodin is a clean, mild, easy-to-use liquid fungicide. It can be used for concentrate or dilute spraying, dissolves instantly, and will not clog screens or nozzles. And, in addition to these benefits, experiment station tests show that some of the commonly used insecticides may tend to be more effective in combination with glyodin than in combination with other commonly used fungicides.

*

' Crestol ', a highly successful new pre-emergence weedkiller which can be safely used for a wide variety of crops as late as 24 hours before crop seedlings emerge, has just been introduced by the Murphy Chemical Co. after exhaustive tests carried out over six years. It is claimed that the new pre-emergence weedkiller combines the advantages of speed, safety and cleanliness. It leaves no residual toxicity in the soil and does not clog spray nozzles.

' Crestol ' is a contact weedkiller, based on high boiling cresylic-type oils, which destroys all annual weeds up to 1 in. high. It can be used with entire safety for a wide variety of crops, including sugar and fodder beet, mangolds, turnips, swedes, potatoes, carrots and onions. Provided the necessary cultivations in preparing the seed bed have been carried out, the application of the new pre-emergence weedkiller shortly before the crop seedlings appear will ensure a field free from weeds and will give the seedlings a chance to get away to a clean start. In good growing seasons, when the number of days between weed emergence and seed emergence are few, quick-acting ' Crestol ' allows the farmer the maximum number of available days for the selection of suitable spraying weather.

WORLD CROP REPORTS

ITALY

Wheat.—Italian production of wheat in 1956 amounted to 8,681,300 metric tons, compared with 9,505,500 metric tons in 1955, according to the Italian Central Institute of Statistics. Of this year's production, 7,247,000 metric tons were soft wheat and 1,434,300 metric tons hard wheat.

NORTHERN RHODESIA

Maize

Three years in succession the surplus maize crop held by the Maize Control Board of Northern Rhodesia has made it unnecessary for the Board to consider imports from outside the territory, according to the Board's annual report for 1955–56.

Commenting on the position, the manager of the Maize Control Board predicted that the crop, consumption and carry-over for this and future years would continue to increase. He estimated that the reserve in hand when depots open on 1 July, 1957, would be sufficient to last for seven months — probably totalling about 794,000 bags.

Consumption in the year 1956–57 would be about 1,300,000 bags (100,000 bags more than in the previous year), and in 1957–58 about 1,400,000 bags. Total European and African crop deliveries to depots during 1955–56 were 915,524 bags—a decrease of 329,369 bags.

FRANCE

Grain crop

Late harvests prevented farmers from taking full advantage of the favourable weather for preparing grain sowing, according to the French Ministry of Agriculture monthly crop report.

The Ministry estimates that the area under wheat next year will be about 4·7 million ha. Frost damage in 1955–56 makes comparison with that season unrealistic, but the 1954–55 area was 4.6 million ha.

Excellent barley and oats spring crops are expected to lead to heavier spring as opposed to autumn sowing of these crops in the 1956–57 season. The quality of the seed is uneven, however.

For the current 1955–56 season the Ministry gives the following details:

Wheat.—The average yield per hectare was 21 quintals, giving a total crop of about 5,694,000 tons. This compares with 22.8 quintals and 10,364,000 tons in 1954–55.

Rye.—The crop was relatively undamaged by the hard winter. The yield per hectare was 12.3 quintals and the total crop 476,200 tons, against 11.4 quintals and 440,360 tons in 1954–55.

Barley.—The switch from wheat to barley after the frost damage to wheat, coupled with excellent ripening conditions, led to substantial increases in yield per hectare and total production. In 1955–56 the yield per hectare was 28.4 quintals, against 20.3 the previous season, and the total crop amounted to 6,502,000 tons, against only 2,670,000 tons in 1954–55.

Oats.—Results were excellent. A yield of 20.7 quintals per hectare produced a total crop of 4,751,000 tons, against 17.5 quintals and 3,639,000 tons in 1954–55.

Maize.—The crop is estimated at 1,787,000 tons and the yield at 27.4 quintals per hectare. This compares with 1,091,000 tons and 24 quintals per hectare in 1954–55.

U.S.A.

Unseasonably cold weather in some north central areas and at higher elevations in the Rocky Mountains limited growth of small grains. About ½ in. or more of rain fell over most of the Mississippi and Ohio Valleys, the Great Lakes region and the north-east, according to the U.S. Department of Commerce weather report for the week ended 24 November.

Rains in the lower Mississippi Valley provided beneficial moisture and grains responded with good growth and are furnishing considerable grazing. East of the Great Plains the crop is mostly in fair to good condition, but insufficient moisture is retarding growth in some south-eastern areas.

In Nebraska melted snow furnished fairly good topsoil moisture in the west and south-east. Wheat improved and is providing some grazing in the south-east.

In Kansas growth has been retarded by drought and cold. Crusted soil in the central area is restricting emergence of late planted wheat and farmers are using rotary hoes to break the surface.

NEW SOUTH WALES

Wheat crop prospects.—The excessive rain and widespread flooding experienced from early autumn to late winter throughout the New South Wales wheat belt caused greatly reduced sowings this season.

It is estimated by the division of marketing and agricultural economics of the Department of Agriculture that about 29 million bushels of grain will be harvested from approximately 1,500,000 acres in the 1956–57 season.

In most cases yield prospects will show some improvement with a period of fine dry weather.

INTERNATIONAL

Coffee

FAO has reported that world coffee production for 1955–56 rose to an all-time record of about 2.6 million metric tons. Coffee prices as a whole remained firm in the first nine months of 1956 and prices for high-quality coffee rose substantially.

Brazilian exports for the first half of this year were 63% higher than for the same period last year. The *Colombian* 1955–56 crop had been reduced by unfavourable weather; nevertheless, with use of some reserve stocks, Colombian exports for the first half of the year were 16% up on exports for the same period of last year. The *Central American* countries sold out their 1955–56 crops profitably early in the year.

Some producing countries in *Africa* found it difficult to dispose of 1955–56 crops, particularly of lower quality coffee, and it was necessary to set up coffee support funds in the *Ivory Coast*, *Guinea*, the *French Cameroons* and, in September, in *Madagascar*.

The outstanding importer was the *U.S.A.*, which increased its purchases in the first half of the year by 25% over the same period last year. In January–May this year *European* imports were 15% up on imports for the first five months of last year, although *French* imports were not increased. European buyers concentrated on higher quality coffee and were ready to pay higher prices than U.S. buyers.

Surveying the future outlook, FAO reported that the 1956–57 Brazilian crop is likely to be much smaller and that exportable production has been

estimated at only 600,000 metric tons. Nevertheless, reserve stocks estimated at about 660,000 metric tons would enable Brazil to meet buyers' demands. Slightly reduced crops were expected in *French African* regions and *Kenya*, while higher production than in 1955–56 was expected from Colombia and other ' mild coffee ' countries.

Sugar

Jamaica.—There has been a small reduction in the estimate of the 1957 sugar crop, the Sugar Manufacturers' Association now forecasting an out-turn of 345,300 tons, which compares with a production this season of 356,309 tons.

Paraguay.—According to the latest estimate, published by the Export Services Branch of the Board of Trade, sugar production this year will amount to about 24,000 metric tons. This is about sufficient to cover domestic requirements.

Philippines.—Sugar production in the 1955–56 crop year amounted to 1,218,531 short (1,087,974 long) tons, compared with the previous season's out-turn of 1,385,231 short (1,236,813 long) tons, according to the Philippine Sugar Association as published by *News from the Philippines.*

Kenya.—Sugar production is estimated this season at 23,000 tons, according to the Standard Bank of South Africa. Consumption is put at about 65,000 tons. It is thought possible that with modern irrigation methods production in Kenya can rise until it is sufficient to meet domestic requirements.

Cuba.—It is reported that the Cuban Government has fixed the size of the 1957 crop at 5,150,000 Spanish tons, which compares with the limit set on the 1956 crop of 4,600,000 tons. It is rumoured that the original recommendation for an initial world market quota of 1,300,000 tons may be adopted.

Czarnikow Rev.

Bread grains

The U.S. Department of Agriculture forecasts a near-record world bread-grain crop in 1956.

' The combined crop of wheat and rye will total about 265 million short tons, second only to the 1952 record of 274 million tons ', the Department said in its weekly publication *Foreign Crops and Markets.*

The Department, in this second forecast, estimated world wheat output at 7,545 million bushels, compared with 1955 production of 7,405 million bushels. Rye production was placed at 1,360 million bushels, compared with 1955 output of 1,485 million bushels. In the first forecast made in September the Department had estimated 1956 wheat production at 7,510 million bushels and rye production at 1,355 million bushels.

The considerably expanded wheat production in the *Soviet Union*, realised in part from new lands, was the ' most important factor in the increase this year ', the Department said. However, the rye crop would be the smallest of the past 10 years.

The outlook for wheat crops now being harvested in Southern Hemisphere countries, especially in *Australia* and *Argentina*, is less favourable than when the world crop was first forecast in September, the Department said.

South America's total wheat crop is now placed at 330 million bushels, 30 million less than the first forecast. The reduction is caused by less favourable prospects in Argentina.

Rye production in Argentina is estimated at 28 million bushels, compared with 26 million a year ago.

The Department said the wheat crop in Australia was expected to total only about 130 million bushels, ' approximately a third less ' than the 1955 crop. This was due to excessive rains in the autumn and dry conditions in the spring.

Though the crop is small, a large carry-over brings supplies to a comparatively high level of at least 130 million bushels above the country's domestic requirements for the year.

ENGLAND AND WALES

Agricultural conditions in England and Wales on 1 December, 1956, have been summarised by the Ministry of Agriculture, Fisheries and Food.

Conditions were generally favourable for cultivations and sowing, and good progress has been made. Autumn-sown crops are generally satisfactory. The lifting of potatoes was almost completed. The quality and condition of tubers are generally satisfactory and the proportion seriously affected by blight is estimated to be less than 5% over the country as a whole. Good progress has been made with the harvesting of sugar-beet and other root crops. Pastures continued to provide keep, and stocks of winter keep were not drawn on to any appreciable extent.

Weather conditions

The weather during November was very dry. Rain, which was mostly light, fell from time to time, but in almost all districts rainfall was less than half the normal figure. Temperatures were about normal, but colder weather was experienced towards the end of the month with widespread frost and gales; there were showers of hail, sleet and snow in northern areas.

Autumn cultivations

Good progress was made during the month with autumn cultivations and over most of the country the arrears of work arising from the protracted corn harvest have been largely overtaken. Good progress was made with sowing, especially on the lighter soils, where good seed beds were obtained.

Autumn-sown crops

Wheat has germinated well on the whole, but growth is rather slow in some areas.

Barley has germinated well and is making good progress.

Oats.—Early-sown crops look well, but some later sowings have been slow to germinate.

Rye is strong and healthy.

Beans were sown later than usual in many areas and are not yet through the ground; some earlier sowings have germinated well and appear to be satisfactory.

Potatoes

Conditions were favourable for lifting potatoes during the month and harvesting is virtually complete in most areas. The quality and condition of tubers are generally satisfactory. The proportion seriously affected by blight is estimated to be less than 5% over the country as a whole, but rather higher percentages are reported from some areas in Wales and the south-west.

Sugar-beet

Good progress was made with the harvesting of sugar-beet. Roots are of good quality, but are rather dirty in some districts.